Engineering Library

March 1941

MAR 14 1941

MACHINE DESIGN

In This Issue:

Shell Lathe Casts Aside Tradition

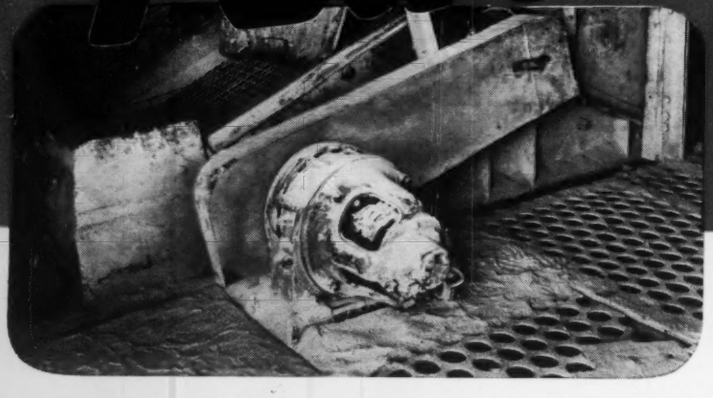
Consider Lighting in Original Design!

Which Type of Control Serves Best?

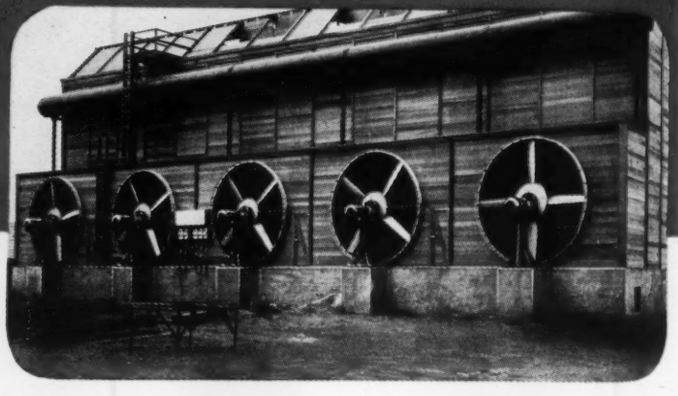
IF YOU WANT PROOF--HERE'S

PROOF

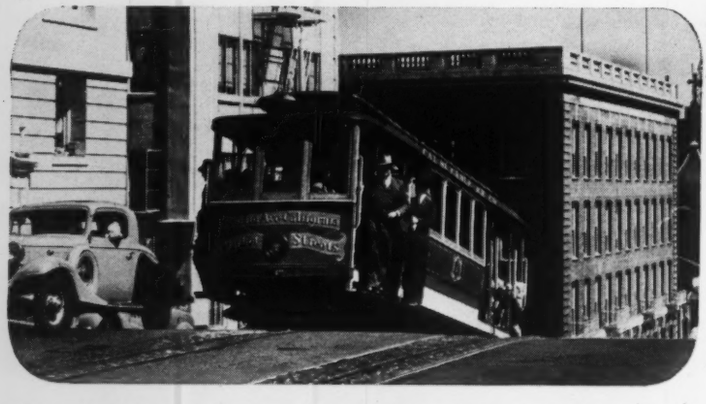
PLUS!



"I'M TOUGH ON MOTORS!" That's what E. H. Humberstone, Superintendent, Marble Cliffs Quarries Co., Columbus, Ohio, says. And he adds — "That's why I use Allis-Chalmers Lo-Maintenance Motors — 187 of them!" Service costs in 15 years on the typical 10-hp Lo-Maintenance Motor shown here driving a screen, have been exactly zero!



MAKES A CYCLONE! Making a man-made cyclone to cool 15,000 gallons of water per minute — that's the job the Panhandle Power & Light Co., Borger, Texas, called upon Allis-Chalmers Motors to perform under weather and operating conditions that would have stumped other motors.



600 HORSES FLATTEN SAN FRANCISCO HILLS Two Allis-Chalmers 300-hp Motors operate San Francisco's historic California Street Cable Car system over hills as steep as 21%. In 26 years of day-after-day service, powering eleven miles of underground cable, there has never been a motor failure!

YOU'LL FIND IT PAYS...

IF YOU want your machines to operate at top efficiency under *all* conditions — use the motor that gives performance that's more than just a rated horsepower!

That's why Allis-Chalmers Lo-Maintenance Motors are so widely accepted by equipment manufacturers who want to take no chances . . . who insist on dependability and long life in the motors they put on their machines.

For, in Lo-Maintenance Motors, you get — no skimping anywhere . . . indestructible rotor . . . distortionless stator . . . high carbon steel frame . . . features that give you *positive* assurance of full-measure performance.

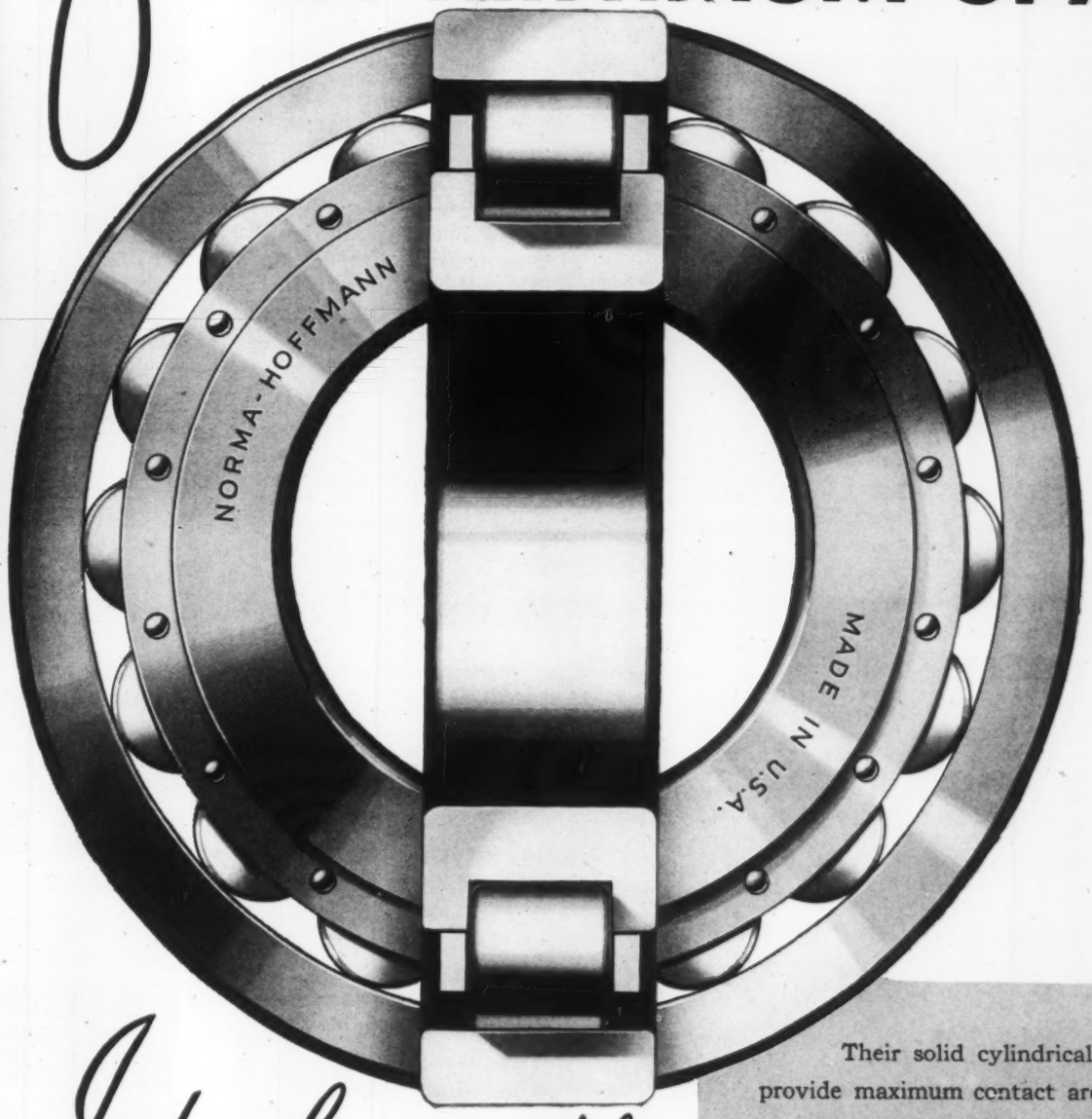
See the experienced power engineer in the district office near you for the complete data . . . or write Allis-Chalmers, Milwaukee, Wisconsin.

A 1363

ALLIS-CHALMERS LO-MAINTENANCE MOTORS

A COMPLETE LINE FOR EVERY PURPOSE...ONE-HALF HORSEPOWER AND UP

for MAXIMUM CAPACITY IN MINIMUM SPACE



Interchangeable

WITH SINGLE-ROW BALL BEARINGS

NORMA-HOFFMANN

PRECISION ROLLER BEARINGS

NORMA-HOFFMANN BEARINGS CORP'N.,

STAMFORD, CONN., U. S. A. • *Founded in 1911.*

Write for the Catalog. Let our engineers work with you.

Their solid cylindrical rollers provide maximum contact area, giving larger load and shock-absorbing capacity than any other single-row bearing of like dimensions. Thus, when NORMA-HOFFMANN PRECISION ROLLER BEARINGS are used in place of ball bearings, a greater factor of safety is provided, together with added life, particularly under vibration and overload. PRECISION qualities in workmanship and materials adapt them alike for both low and high speeds.

Topics

DESIGNERS have reason to be proud of the concern the government is showing for the shortage of men in their profession. Nine million dollars, to be administered by the U. S. office of education, has been appropriated for the free training of men to fit them for immediate service in industrial phases of the defense program. It has been estimated 57,850 students will be given intensive training with the co-operation of 119 engineering colleges. First program to get under way was that offered by Brown university and the Rhode Island School of Design, in Providence. Two hundred and ten workers will meet twice a week for at least 20 weeks, taking courses in machine design fundamentals, engineering mathematics and drawings, and jig and fixture design. In New York City, eight engineering schools are contributing to a similar program.

♦

WORD from Lincoln Electric's London representative says an estimated cut of approximately 15 per cent in British industrial production from air raid damage has been largely offset by improved manufacturing methods. Lincoln is quick to point out that wider application of welding processes, coupled with use of large size electrodes, have been major factors in keeping up the British output.

♦

IN VIEW of the frequent cries of dismay about this country's dependence on imports for a few vital defense materials, it's comforting to learn that 75 per cent of the tonnage of all the raw materials used by the steel industry can be supplied by that industry itself. All but one-half of one per cent of the remainder can be furnished by domestic suppliers. Unfortunately, however, the materials which must be imported are essential, and no adequate substitutes for them have been discovered.

♦

STRENGTH ten times that of ordinary "safety" glass is claimed for Flexseal, recently announced by Pittsburgh Plate Glass Co. Like other varieties, Flexseal has a layer of plastic sandwiched between two sheets of glass, but in addition its sheet of plastic extends beyond the edges of the glass to serve as a flexible rim, helping to fasten the unit in place. Several requirements of the aviation industry are said to have been responsible for Flexseal's development. These include the need for stronger glass at elevations of 20,000 feet or more; necessity of freedom from torsional strains sometimes encountered when a rigid sheet of glass is mounted; and the need for making the glass flush with the skin of the plane.

♦

UNDOUBTEDLY the number of gears sold annually or monthly has some relationship to the number of machines designed and produced, although the proportions cannot be direct. Hence it's interesting that sales of industrial gears for January, 1941 were 110½ per cent above those a year ago, and 24½ per cent above those in December, 1940.

♦

IT MIGHT be called camouflage; at any rate, it's an unusual use of industrial finishes. Shells and bomb parts, finished in bright colors for identification but with glossless surfaces to render them inconspicuous at a distance, formed one feature of a large recent exhibit of modern lacquers and enamels.

♦

FLUSH, or countersunk, rivets have been adapted for commercial use, following successful employment of them on Lockheed bombers. Increase in speed of twelve miles an hour is said to be attributable directly to Lockheed's adoption of these fastenings.

♦

EVEN more revolutionary may be the riveting process with which Ford is rumored to be experimenting, primarily for use in aircraft assembly. The more sensational reports say a reduction of 50 per cent would be effected in time and labor required for plane production.

MACHINE DESIGN

Shell Lathe Design Unfettered by "Standard Practice"

By Myron S. Curtis

POTENTIALITIES of the machine tool industry for constructive achievement in furtherance of defense work are no better exemplified than by the new lathes for producing shell. For years manufacturers of versatile, high precision machine tools, the industry was assigned the problem of designing machines to the following specifications.

(1) Capable of economical production of shell in sizes from 3 inches to 6 inches
(2) Sufficiently automatic to be operated by unskilled labor
(3) Capable of performing all shell machining operations with a minimum of modifications
(4) A single-purpose machine, need not be adaptable to general shop work
(5) Simple in construction, capable of being made in other than machine tool plants

Reasons for specifications (2), (4), and (5) deserve some consideration. Though shell manufacture is

NOTEWORTHY because of its departure from established conceptions of what constitutes a machine tool, this shell lathe was designed by the author for the defense committee of the National Machine Tool Builders association. The article analyzes the outstanding design features of this single-purpose machine which is capable of being built with virtually no machining on the base

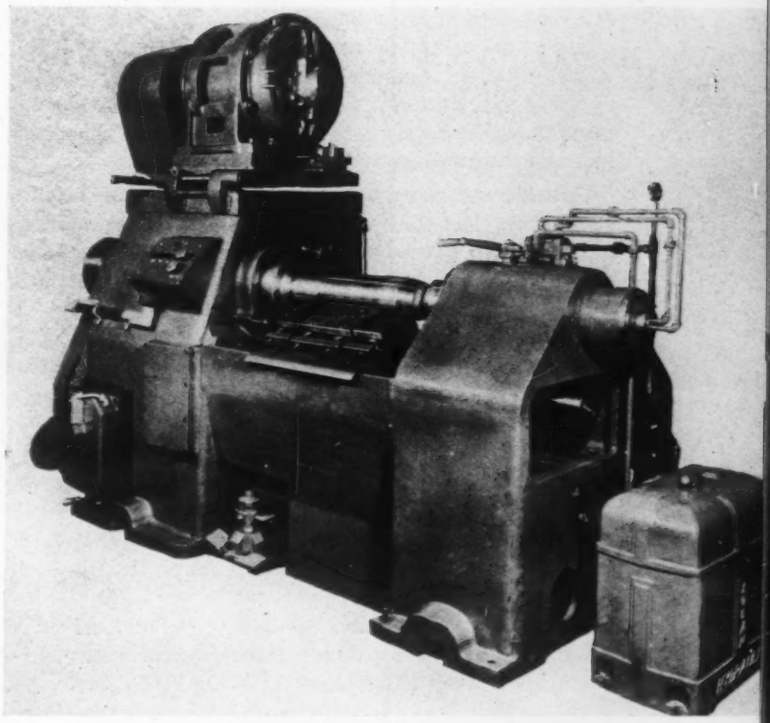


Fig. 1—Six of these shell lathes, each incorporating minor modifications depending upon the machining operation, form an assembly line which produces finished shells at high rate of speed from forged blanks

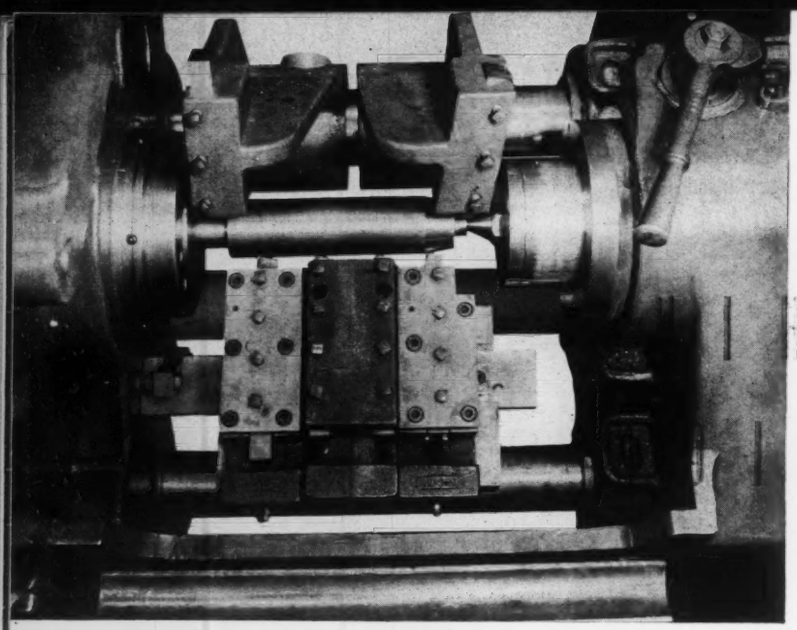


Fig. 2—Plan view shows turning and forming tool holders. Pouring holes for alloy used to position bushings may be seen on the right or tailstock end

highly important, it is not a precision job. The closest limit is .005-inch and most limits are from .02 to .03-inch. Shortage of skilled machinists requires that such men be reserved for the many other precision jobs in industry. For this reason, the shell lathe is designed with simple controls assuring foolproof operation so that unskilled operators can be used.

Bearing in mind that the primary purpose of these lathes is to expedite the defense program by producing shell as quickly and economically as possible, it became immediately apparent that these conditions could best be met with a single-purpose machine. Whereas it would be possible to build the lathe with a tailstock assembly capable of sliding on ways and hence usable for other purposes than making shell this would entail planing of the base and tailstock as well as some sacrifice of rigidity. Also removable and interchangeable feed cams could be designed into the machine to increase its flexibility.

Consideration of such factors, however, led to the conclusion that they would not only increase machine cost but also extend the time necessary for construction, two vitally important points. Therefore the lathe was designed as a single-purpose machine despite the fact that, after having fulfilled its function, it would be fit only for the cupola or for storage for a future emergency.

Reserves Plants for Precision Jobs

Specification (5) is justified on the basis that it frees the machine tool plants for the production of high precision machines vitally essential in so many other branches of the defense program.

The resulting machine stands to the credit of an industry which, in the face of the present emergency, has proved itself capable of throwing aside convention and preconceived ideas to develop a tool which admirably fulfills all of the aforementioned specifications.

Designed to be made in two sizes, the smaller lathe machines shells from 3 inches to approximately 4 inches, the larger from 4 inches to 6 inches. The 6-inch lathe is shown in *Fig.* 1 although the design details are identical in both.

Because one of the primary requirements for the machine is that it be built in other than machine tool plants, it was desirable that a minimum of machine work be done on the base. It was therefore necessary to eliminate all plane working surfaces as well as all boring and facing. This was accomplished by mounting the turning carriage on a longitudinally slidable as well as rotatable bar as shown in the plan view, *Fig.* 2. Instead of supporting the outer end of the tool carriage on a plane surface as is done conventionally, this support is also provided by a bar. This latter bar, the lower one in the illustration, also effects movement of the tools toward and away from the work. An end view of this mechanism is shown in *Fig.* 3. Advance of the tool into cutting position is achieved by counterclockwise rotation of the bar. The cams fastened to the bar thus pick up the tool carriage and swing the tools into the cutting position illustrated. At the conclusion of the cut, the bar is rotated clockwise, retracting the tools.

Facing tool arms are mounted on a third bar shown in the upper portion of *Fig.* 2. Utilization of this method of tool carriage support and control obviates the necessity of any machined surfaces on the base of the lathe.

Bushings Poured in Place

It is, of course, essential that these three support bars be maintained substantially parallel with the tailstock and spindle assembly. Installation of unit bearings, either plain or antifriction, would require precise boring of the machine base. This was deemed impractical in view of the conditions under which the machines are to be built. The final solution of the bearing problem was simple and yet effective.

Considerably oversize bushing housings were cored in the base and provided with an opening on their upper cylindrical surface. These housings and the holes are shown in *Fig.* 2. Bushings were slipped over pilot bars which were then supported, with the bushings in their proper positions in respect to the machine base, by a fixture specially designed for this purpose. The annular openings between the bushings and the housings were carefully dammed.

A special alloy consisting of a high bismuth content as well as lead and tin is poured into the bushing housing through the holes provided for this purpose. In this operation the alloy is heated to 450 to 500 degrees Fahr. at which temperature it flows like water. The material possesses the peculiar property of expanding somewhat upon both solidification and cooling, and hence must be allowed to set for about twelve hours before being subjected to load.

Pilot bars may be removed from the bushings as soon as solidification takes place. If the thickness of the walls has been properly figured there will be no distortion and the bars installed later will be in as close alignment as the fixture. With this process twenty-one bushings may be set in place in about one hour constituting a substantial economy.

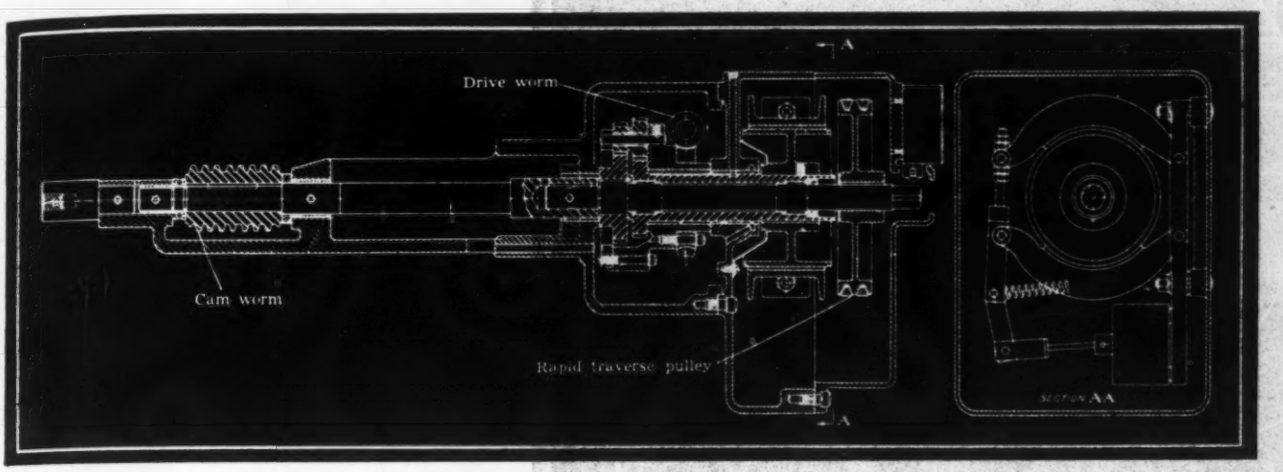


Fig. 4—Feed mechanism is designed to be controlled for all operations by a solenoid and motor. Spur gear differential is shown in about the center of the illustration

To eliminate machining of the gasket surfaces of the base a similar technique is followed. The cover plate to which the motor support is hinged for belt adjustment is shown in *Fig.* 1. A groove is cast entirely around the top of the headstock housing where it is in contact with the cover plate. Bearing alloy is poured into this groove where, finding its own level by gravity, it affords a parallel, smooth and tight gasket surface for the cover plate.

Spindle drive is from the motor through V-belts

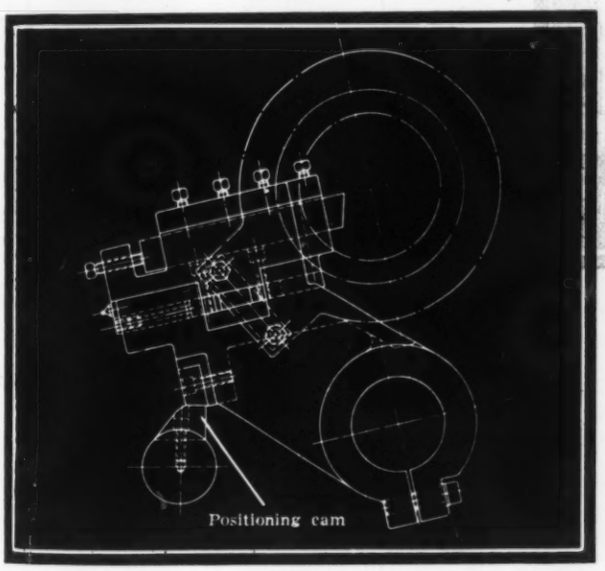


Fig. 3—Main tool carriage supporting bar is located on the right. Positioning cam is fastened to oscillating bar

to a driveshaft, then through a jackshaft to a spindle. To maintain tension in the belts, set screws are tapped into the motor support plate and bear on the cover plate. Tightening down these screws raises the motor about the support plate hinge and imposes tension in the V-belts. The spindle, as do all the other shafts, runs in plain bearings. These bearings are bronze, lined with about .03-inch of babbitt.

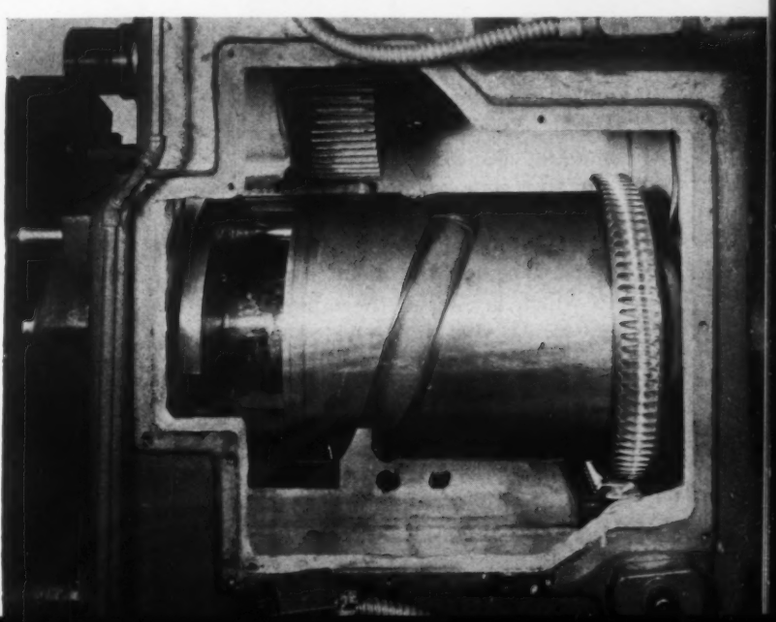
In specifying that this lathe be a single-purpose machine, considerable latitude was permitted the designer for achieving both simplicity and economical construction. The most radical departure in this machine from conventional design was employed in the mechanisms for feeding and returning the turning tool carriage, for positioning this carriage and for feeding the facing tool swing arms.

Shown in *Fig.* 5 is the camshaft which accomplishes these three operations. The cylindrical drum cam feeds the tool carriage through the cutting and return motion. At the left of the drum cam and mounted on the same shaft are two plate cams. One of these operates, through a swing arm and shaft, the facing arms shown in *Fig.* 2. The other, through a swing arm and linkage operates the oscillating bar for supporting and positioning the turning carriage as discussed in connection with *Figs.* 2 and 3.

Since it is essential that the tool carriage feed be a direct function of the spindle speed, the feed drive is taken from the spindle shaft by means of a silent chain. This chain drives, through a pair of pick-off gears, the drive worm shown in *Fig.* 4. The mechanism shown in this illustration best typifies the originality characteristic of this lathe and so merits detailed consideration.

The problem was one of providing a tool carriage

Fig. 5—Drum cam traverses tool carriage. In the lower right is seen the cam driving worm mounted on the feedshaft shown in Fig. 4



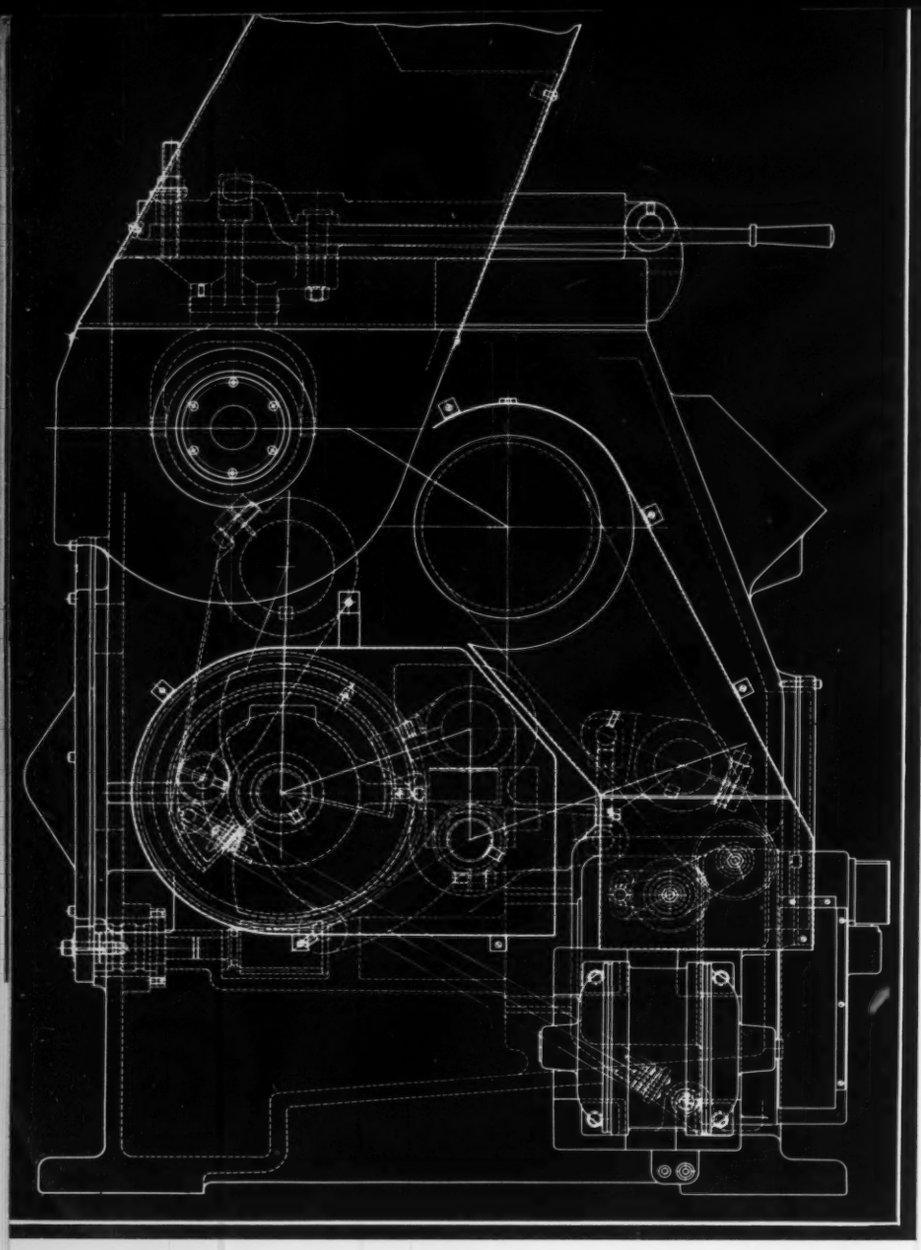


Fig. 6—View of head end shows the position of all support bars, camshaft and feed box. Feed box drive motor is shown at the lower right

feed driven from the spindle which would be both simple and economical. In addition, it must provide a positive cutting feed and a quick return motion, both of which are capable of being operated either automatically or manually through a minimum of controls. The following will demonstrate how all these conditions were fulfilled.

Driven by the drive worm is a wormwheel bushed on a sleeve in the feed box, *Fig.* 4. Integral with the worm gear is a cage carrying a stud on which is mounted the planet gears. Fastened to this sleeve is one sun gear of the planetary system and a brake drum. Concentric with this sleeve is a feed shaft, the left end of which carries a worm which drives the wormwheel on the drum cam shown in *Fig.* 5, and to which is keyed the other sun gear of the differential. To the right end of this shaft is fastened a V-belt pulley which is driven by an auxiliary motor shown in the lower right of *Fig.* 6. This motor is in the same control circuit as the solenoid which operates the brake in *Fig.* 4.

During the cutting pass of the tool carriage the brake is applied to the drum, holding the sleeve stationary. The cam worm shaft is thus driven through the planets and the second sun gear keyed on the shaft adjacent to the first which is then stationary with the sleeve.

When the tool carriage is to be retracted the brake is released and the motor, being energized, drives the cam worm shaft at high speed. Although the spindle, and hence the drive worm, is turning, it effects merely the free rotation of the planet cage, sleeve and brake drum.

Thus the three conditions of tool slide operation, namely, stop, free and fast advance and return, are controlled by a solenoid and a motor. If neither are energized the feed shaft is stationary. If the solenoid is energized and the motor de-energized, the feed shaft will be rotated at a speed synchronous with the spindle, the armature of the motor rotating idly. If the solenoid is de-energized and the motor energized the feed shaft is rotated at high speed, for idle movement of the carriage.

Complete feed control by a single solenoid and motor is easily adaptable to either manual or automatic operation. Since both are electrically operated the controls can be located in any convenient position.

Automatic control is attained by limit switches operated by adjustable dogs located on disks fastened to and driven by the cam shaft. Pushbuttons mounted on the spindle housing shown in *Fig.* 1 provide manual control when desired.

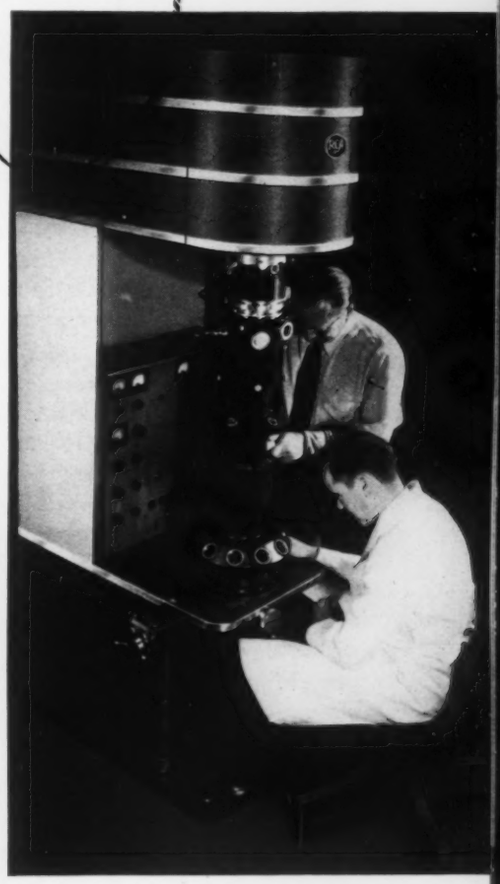
To rough turn the shell nose and tail profiles former cams are used. These cams are of the plate type; the one for shaping the nose may be seen directly under the tool carriage in *Fig.* 2. Profiling tools which engage the former cams are slidable transversely on the tool carriage.

Angular turning operations may be accomplished by means of a cam on the oscillating bar rather than by a plate forming cam. This oscillating bar cam together with the feed cam produces the desired angular motion of the tool.

The machine has a live tailstock center which is hydraulically operated. Further simplification of control is achieved by utilizing the movement of the binder lever, shown in *Fig.* 2, to effect the movement of and also to clamp the tailstock. The hydraulic piston is stationary; the piston rod is hollow and serves as a conduit for fluid. The cylinder, which carries the live center, is free to move longitudinally in a bushing. A single movement of the binder lever operates the valve which advances the tailstock and clamps it in position. Reverse motion of the lever

(*Concluded on Page* 74)

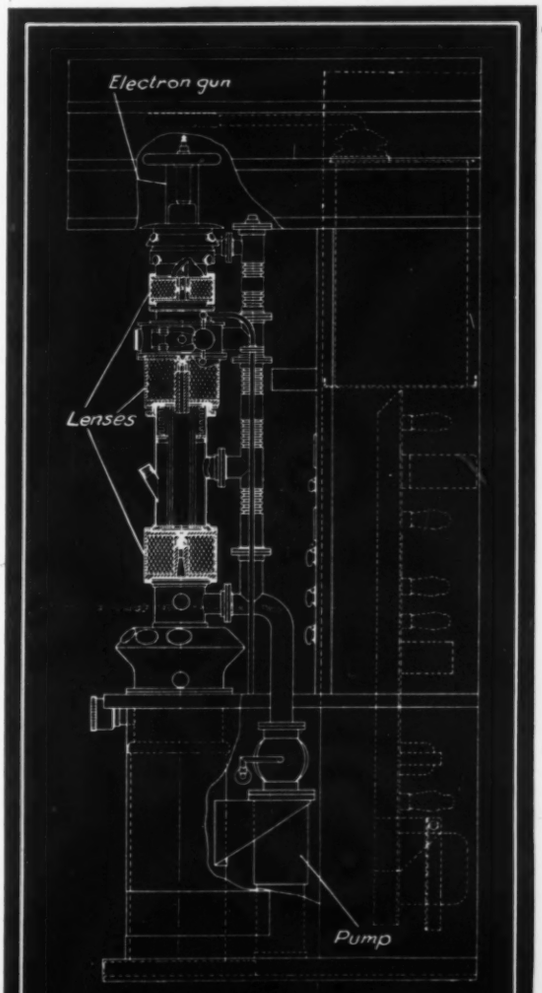
Scanning the Field For Ideas



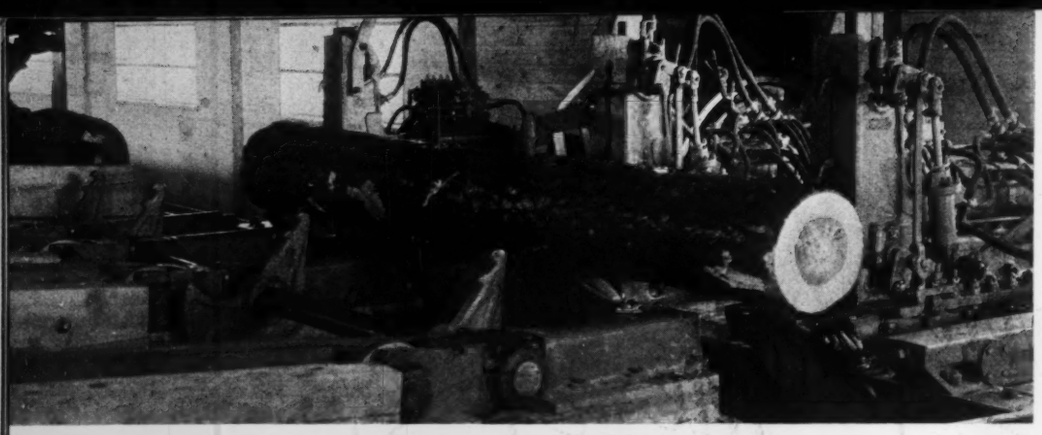
Magnetic lenses direct a stream of electrons at tremendous speed through the RCA microscope, illustrated, to produce magnifications from 20 to 50 times greater than is possible with light microscopes. Based on the same principles used in optical units the instrument employs axially symmetric fields for the lenses and electrons moving with a velocity corresponding to 60 kilovolts with a wavelength about 1/100,000 that of light.

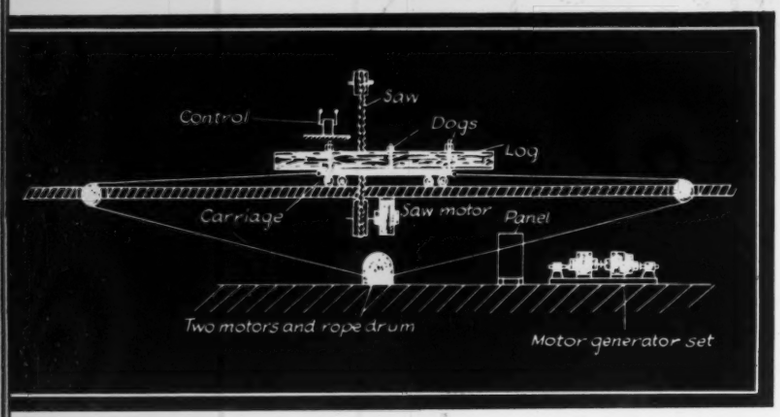
Not only the microscope itself is included in the unit but also the regulated power supplies for the overall voltage and the current for the magnetic lens coils. A three-stage oil diffusion pump for maintaining a vacuum within the instrument as well as an auxiliary pump are likewise within the unit.

To prevent repumping the entire microscope each time a specimen or photographic plate is changed, air locks are provided to prevent breaking the main vacuum. A handle at the rear of the object chamber raises the object from its position over the objective, moves it into the airlock and closes the latter off from the main chamber. An auxiliary pump is used for a preliminary exhaust of the airlock chamber before returning a specimen to the object chamber.



Electrons used in the imaging process are supplied from the electron gun and are caused to converge upon the specimen by passing through a magnetic field produced by an iron-clad coil with specially shaped pole pieces. Another magnetic field, acting as an objective lens, deflects the electrons and focuses them as an intermediate image. The objective is also an armored coil and refocuses the image in the plane of a photographic plate or observing screen with a magnification between 2000 and 30,000 diameters.





Shot-gun feed for rapid acceleration and retardation of sawmill carriages is obtained as shown in the schematic sketch at left. Traveling at a forward speed of 600 feet per minute and returning at 800 feet per minute, the carriage is driven by two 80-horsepower General Electric motors with steel haulage ropes attached to both ends of the carriage in such a way that one winds on and the other off a sheave in each direction.

Motor shafts have electrically tripped emergency brakes capable of stopping carriage within six feet even at highest speed. Power for drive is supplied with adjustable voltage control by a motor-generator set having amplidyne excitation. Energy stored in the carriage is returned to the electrical system by regenerative braking. Thus the power consumed is only that required to supply the losses. Also, regeneration produces a cushioning action at each end of travel.

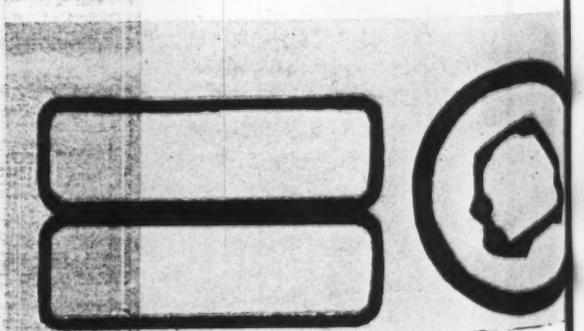
With this type of drive, one watt of power can be utilized to control many kilowatts. Also, almost instantaneous response to changes in power input reduces time lag to a minimum between adjustment of the control and response.

Helical rotor pumps originally conceived by a French inventor, R. Moineau, have been developed by the Food Machinery corporation as shown at right. The long rotor compounds the lifting force so that relatively large capacities can be pumped from a small bore.

Hard chrome, heat-treated stainless steel is utilized for the rotor and is precision ground and polished. It fits a companion helical surface inside the stator which is locked to the bottom of the pump column inside a metal sleeve. Lifts of 100 feet can be effectively provided.

No waste is encountered in making gaskets at right. A ligno-neoprene composition developed by Chrysler corporation, it is sheeted on calenders, cut to correct size and cured on mandrels in hot air ovens. The waste material is resheeted. Materials are all domestic and composition may be modified for many applications. Resistant to oil up to 400 degrees Fahr. and to gasoline up to 200 degrees, it has however a tendency to swell in the presence of water.

Illustrating the close connection between plastics and synthetic rubber, this material is an outgrowth of developments resulting from experiments with lignin as a plastic for steering wheels.



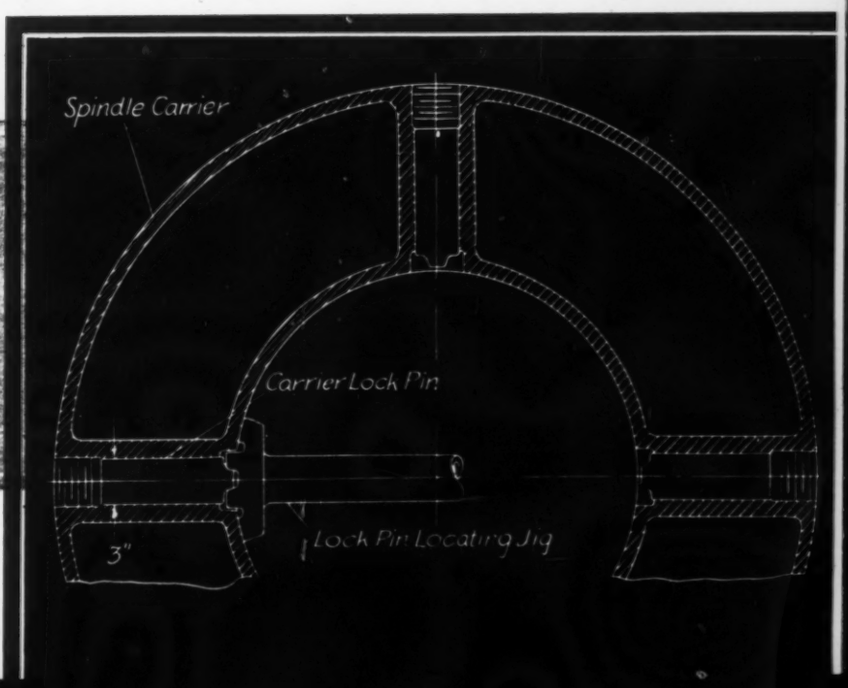
Split seconds are easily measured in a new device developed by the research division of Remington Arms Co. Built into a small cabinet as shown at left, it splits a second 1000 ways and can measure any number of these milliseconds with less than one per cent error.

Termed a chronoscope, the instrument indicates the time interval from a quantity of electricity which passes through a specially designed galvanometer while the measured event is taking place. A vacuum tube switching circuit starts the current at the beginning of the interval and stops it at the end. A photoelectric tube can be used to obtain the start and stop impulses. In ballistic studies such as shown in the photograph, the conventional muzzle wire and target plate are used.

Velocities can be measured accurately over distances as short as five or ten feet providing an electrical impulse can be obtained at the beginning and end of the event. Remaining velocity can also be measured after the projectile has travelled some distance.

Exact location of shrink-fit pins requires a special device to place the pin accurately in position within the time limit of ten seconds before expansion takes place. At right is shown a spindle carrier of a Bullard Mult-au-matic with shrink-fit lock pins having .0015 to .002-inch press fit. After the pins are in position, machining is necessary to correct the distortional errors which the tight pins produce.

In the drawing is shown the locating jig which removes the pins from a solution of dry ice and acetone and accurately positions them for depth and alignment. Formerly, driving the pins home with a sledge took from six to eight hours for six pins in each assembly. With the new shrink-fit method the time has been reduced to one hour.



Applying Theory of Elasticity in Practical Design

By R. E. Orton
Chief Engineer
Acme Steel Co., Chicago

Part II

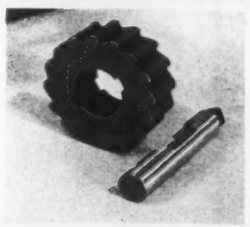


Fig. 8—Top—Although loading was doubled through redesign of this strapping machine there was no increase in weight. Middle illustration shows new ratchet and pawl

Fig. 9—Above—Release cams, redesigned with the aid of elastic theory, reduce release effort by 75 per cent on machine

VALUE of the practical applications of the theory of elasticity is shown in *Figs.* 8 and 9, front and rear views respectively of a hand operated strapping machine. The initial design requirements involved the doubling of the pull of an existing tool without increasing its weight.

As the stress at the contacting surface of the pawl and ratchet shown in *Fig.* 8 was already excessive, this apparently could not be done without radical changes in design. The obvious solution would be to increase the diameter of each part. Such a change, however, would effect the proportion of almost every other part, greatly increase the weight and require a complete new tooling program.

By the application of the Hertz contact stress equation, a new contour for the pawl and a new form for the ratchet teeth were determined which brought the stress within a safe limit without any change in the size at all. This permitted the use of the entire pattern equipment on hand and 75 per cent of the tooling equipment. Although these new tools have now been in the field over two years no failure has been experienced.

Design details of this pawl and ratchet and of the release cam shown in *Fig.* 9 will be discussed later in an article on contact stress in general. This, the second article dealing with the fundamentals of elastic theory, will develop strain differential relations as well as solutions by stress function.

Part I demonstrated how the location of a strained point is determined by its initial coordinates (x, y, z) and the strain coordinates (u_x, u_y, u_z); and then developed from the "second principle" the differential relations for the rate of the change in the position of the point when the body is stressed.

It has been demonstrated that ϵ_x and ϵ_y depend upon u_x and u_y. The same dependence exists for γ_{xy}. Therefore a relation between the shear unit strain and the normal unit strains may be expected. Differentiating $\gamma_{xy} = \partial u_x/\partial y + \partial u_y/\partial x$, (Equation 5) once each with regard to x and y,

$$\frac{\partial^2 \gamma_{xy}}{\partial x \partial y} = \frac{\partial^3 u_x}{\partial x \partial y^2} + \frac{\partial^3 u_y}{\partial x^2 \partial y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Now differentiating $\epsilon_x = \partial u_x/\partial x$ (Equation 4) twice

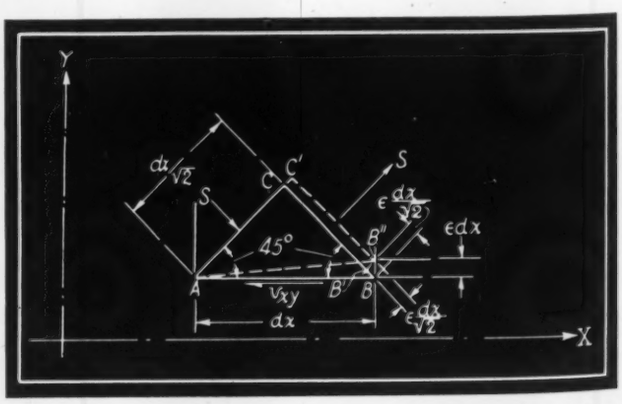


Fig. 10– Pure shear on an elemental triangular prism

with respect to y, and $\epsilon_y = \partial u_y/\partial_y$ twice with respect to x and substitute in (8),

$$\frac{\partial^2 \gamma_{xy}}{\partial x \partial y} = \frac{\partial^2 \epsilon_x}{\partial y^2} + \frac{\partial^2 \epsilon_y}{\partial x^2} \quad \ldots\ldots (9)$$

Similar relations may be developed for γ_{xz} and γ_{yz},

$$\frac{\partial^2 \gamma_{xz}}{\partial x \partial z} = \frac{\partial^2 \epsilon_x}{\partial z^2} + \frac{\partial^2 \epsilon_z}{\partial x^2} \quad \ldots\ldots (10)$$

$$\frac{\partial^2 \gamma_{yz}}{\partial y \partial z} = \frac{\partial^2 \epsilon_y}{\partial z^2} + \frac{\partial^2 \epsilon_z}{\partial y^2} \quad \ldots\ldots (11)$$

The condition given by these three equations is known as the "condition of compatibility." It gives the relationship that must exist between the unit strains in order that the stress system producing these strains be compatible with the concept of "a continuous distribution of the strain."

In order to make use of the condition of compatibility, the relation between the unit stress and the unit strain must be known. "Hooke's Law,"

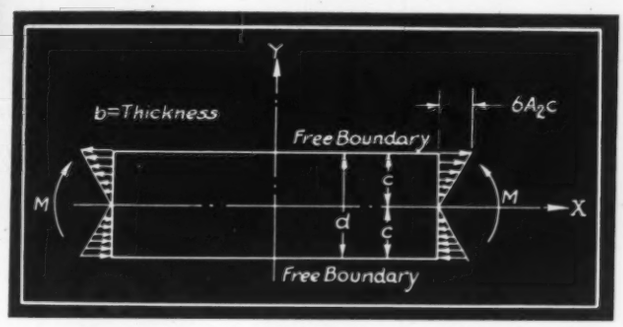


Fig. 11—Beam under uniform bending

which has been experimentally determined, states that the "unit strain produced by a unit stress is directly proportional to the stress producing the strain." That is, if S_x is the only direct stress acting to produce a strain,

$$\epsilon_x = \frac{S_x}{E}$$

where E ("Young's Modulus") is the constant of proportionality for the material in question, assumed as constant in all directions and the same for compression as for tension.

This modulus, E, may be evaluated by testing a bar in simple tension, from which,

$$E = \frac{S_x}{\epsilon_x} = \frac{Pl}{Au}$$

in pounds per square inch where A is the cross section area, P the load, and u the extension in length l. For steels, excluding the high alloyed steels such as high speed, E lies between 29 and 30 million.

Increase in length of an element from a tensile stress has been found to be accompanied by a contraction in the two lateral dimensions. For any given material the ratio of the unit lateral contraction to the unit extension is a constant. Denoting this constant, "Poisson's Ratio," by λ the following is obtained for simple tension,

$$\epsilon_x = \frac{S_x}{E}; \quad \epsilon_y = -\lambda\epsilon_x = -\lambda\frac{S_x}{E}; \quad \epsilon_z = -\lambda\epsilon_x = -\lambda\frac{S_x}{E}$$

the minus sign indicating contraction. The opposite phenomena occurs for the case of simple compression, so that the above equations hold for stresses in either direction. For steels, limited as before, $\lambda = .3$.

If there are stresses in the Y and Z directions also, they will produce their extensions and contractions independently of S_x. By superposition then

$$\epsilon_x = \frac{1}{E}\left[S_x - \lambda(S_y + S_z)\right] \quad \ldots\ldots (12)$$

$$\epsilon_y = \frac{1}{E}\left[S_y - \lambda(S_x + S_z)\right] \quad \ldots\ldots (13)$$

$$\epsilon_z = \frac{1}{E}\left[S_z - \lambda(S_x + S_y)\right] \quad \ldots\ldots (14)$$

From the above it is apparent that the normal stresses produce normal strains unaccompanied by any distortion of angle.

Distortion caused by the shear stress v_{xy}, acting alone, is presented in the triangular prism of *Fig.* 10. The principle stresses are on the 45 degree planes with directions as indicated. From Mohr's circle diagram, *Fig.* 2

$$S = v_{xy} \quad \ldots\ldots (15)$$

The unit strains in the principal directions are equal numerically but opposite in sign and, from Equation 12 are given by

$$\epsilon = \frac{1}{E}\left[S - \lambda(-S)\right] = \frac{(1+\lambda)S}{E} = \frac{(1+\lambda)v_{xy}}{E} \quad \ldots (16)$$

The strain along AC extends that arm of the triangle to C' where

$$CC' = \epsilon\frac{dx}{\sqrt{2}}$$

and the strain along CB shortens this arm of the triangle an equal amount to B', the net result being to move B to B'' where BB'' is perpendicular to AB. The movement of B to B'' is given by

$$BB'' = \sqrt{(BB')^2 + (CC')^2} = \sqrt{2}(CC') = \epsilon dx$$

The angular change BAB'' is given by

$$\angle BAB'' = \frac{(BB'')}{dx} = \epsilon = \frac{(1+\lambda)v_{xy}}{E}$$

A similar result may be obtained for the change in angle of the vertical line at A due to v_{yx}. Since $v_{yx} = v_{xy}$ these angles will be equal. Therefore

$$\gamma_{xy} = 2\angle BAB'' = 2\epsilon = \frac{2(1+\lambda)v_{xy}}{E} \quad \ldots\ldots (17)$$

Similarly for γ_{xz} and γ_{yz}

$$\gamma_{xz}=2(1+\lambda)\frac{v_{xz}}{E} \quad \ldots\ldots (18)$$

$$\gamma_{yz}=2(1+\lambda)\frac{v_{yz}}{E} \quad \ldots\ldots (19)$$

The assumption is now made that the system of normal strains Equations 12, 13 and 14 and the shear strains Equations 17, 18 and 19 may be superimposed on each other without changing the effect of each acting separately.

It should be noted that the above development involves a number of approximations which are very close only if the deformations are relatively small. The superposition of strains is also justified only on the basis of small deformations. While this is the usual case, there are those where it will not hold. An example is a very long column where the loading produces a considerable deformation.

Sometimes the unit shear strain is expressed as

$$\gamma_{xy}=\frac{v_{xy}}{G} \quad \ldots\ldots (20)$$

where G is the "shear modulus." Equating Equation 20 to 17 gives for the relation between G, E and λ

$$G=\frac{E}{2(1+\lambda)} \quad \ldots\ldots (21)$$

Using the values of E and λ previously given for steel gives $G = 11.2$ to 11.5 million.

Reducing these equations to the conditions of plane stress, for which may be written

$$S_z=0;\ v_{xz}=0;\ v_{yz}=0 \quad \ldots\ldots (22)$$

and from Equations 18 and 19

$$\gamma_{xz}=0;\ \gamma_{yz}=0 \quad \ldots\ldots (23)$$

and from Equations 12, 13 and 14

$$\epsilon_x=\frac{S_x-\lambda S_y}{E} \quad \ldots\ldots (24)$$

$$\epsilon_y=\frac{S_y-\lambda S_x}{E} \quad \ldots\ldots (25)$$

$$\epsilon_z=\frac{-\lambda(S_x+S_y)}{E} \quad \ldots\ldots (26)$$

and from 17

$$\gamma_{xy}=2(1+\lambda)\frac{v_{xy}}{E} \quad \ldots\ldots (27)$$

Equation 26 shows that the strain in the Z direction is directly proportional to the sum of the stresses in the X and Y directions. Since, as may be seen from Mohr's circle diagram, *Fig.* 2, $S_x + S_y = S_1 + S_2$, the strain in the Z direction is also directly proportional to the sum of the principal stresses. A very delicate lateral extensometer has been devised by Coker which permits of the measurement of this lateral deformation, from which the principal stress sum may be determined. Since the photoelastic method determines the stress difference, the use of the two in conjunction will permit the determination of the stress distribution throughout the body.

Theoretically there is now sufficient development to mathematically solve a plane stress problem. A stress system could be assumed, checked to Equations 1 and 2, the strains determined from 22 to 27 inclusive, and these checked to the compatibility condition of 9, 10, and 11. If these equations were satisfied the system could now be extended to the boundary to determine the loads that would produce the assumed stress distribution. This method will be illustrated by the following simple case, and then the equations will be developed to a more usable form.

Assuming the stress distribution given by

$$v_{xy}=A_1;\ S_x=0;\ S_y=0$$

substitution in Equations 1 and 2 shows that the first principle is satisfied. Substitution in 24, 25 and 26 shows that the unit strain in all three directions is zero. Substitution in 27 gives

$$\gamma_{xy}=2(1+\lambda)\frac{A_1}{E}$$

Substitutions of these strain values in Equations 9, 10, and 11 show the second principle satisfied. Therefore this stress distribution is permissible. Extending to the boundaries of a rectangular plate gives

$$v=A_1;\ q=0$$

where v is the intensity of the shear load on the boundary, positive for positive direction of shear stress, and q the normal load, positive when a pressure, as the loading that will produce the assumed stress distribution. This is the condition of stress

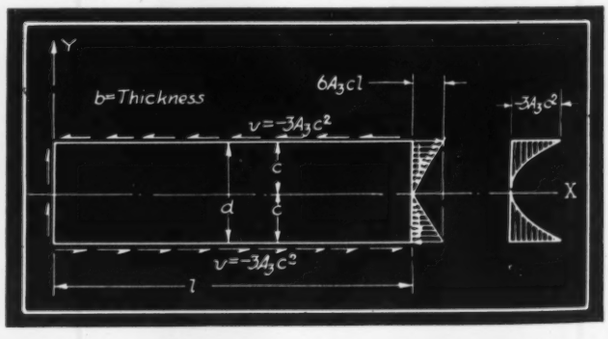


Fig. 12—Loaded beam for which parabolic distribution of shear for both ends is shown at right

illustrated for an elemental prism by *Fig.* 7. The solution will be used later by superimposing on another solution to obtain a third.

The relations of Equations 9, 10, and 11 and 22 to 27 may be combined to give but one equation to consider for the condition of compatibility. To the conditions of 22 and 23 for plane stress may be added that S_x, S_y, and v_{xy} will not vary in the Z direction. Therefore their derivatives with respect to z are equal to zero. Differentiating 24, 25, 26 and 27 with respect to z, then, shows that the derivatives of the strains with respect to z are equal to zero. Substituting in 10 and 11 and adding yields

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\epsilon_z=0$$

Substituting for ϵ_z from 26

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)(S_x+S_y)=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (28)$$

Now substituting the values of 24, 25, and 27 in 9 gives

$$2(1+\lambda)\frac{\partial^2 v_{xy}}{\partial x\partial y}=\frac{\partial^2}{\partial y^2}(S_x-\lambda S_y)+\frac{\partial^2}{\partial x^2}(S_y-\lambda S_x)$$

An expression for $\partial^2 v_{xy}/\partial x\partial y$ can be developed from 1 and 2. Differentiating 1 with respect to x and 2 with respect to y and adding

$$2\frac{\partial^2 v_{xy}}{\partial x\partial y}=-\frac{\partial^2 S_x}{\partial x^2}-\frac{\partial^2 S_y}{\partial y^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (29)$$

Substituting this in the above equation and reducing gives Equation 28 again. Therefore, if the stress

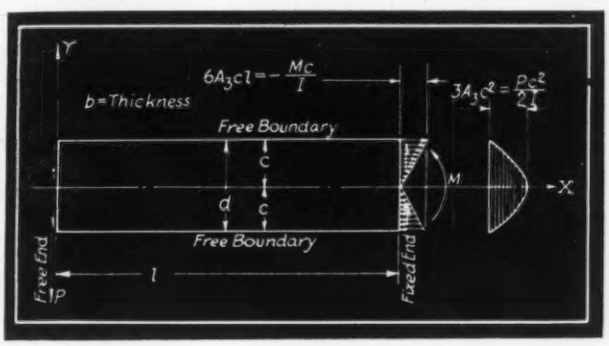


Fig. 13—Cantilever beam loaded at end, showing parabolic distribution of the shear for both ends

system meets the requirements of 28 it will be "compatible."

For plane strain the conditions are

$$\epsilon_z=0;\ \gamma_{xz}=0;\ \gamma_{yz}=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (30)$$

and the strains do not vary in the Z direction, therefore the derivatives of the other strains with respect to z are also equal to zero.

Substitution of 30 in 18 and 19 shows

$$v_{xz}=0;\ v_{yz}=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (31)$$

Substitution in 14 gives

$$S_z=\lambda(S_x+S_y) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (32)$$

from which the transverse loading required to maintain plane strain may be determined.

Substitution of 32 in 12 and 13 gives

$$\epsilon_x=\frac{1+\lambda}{E}\left[S_x-\lambda(S_x+S_y)\right]$$

$$\epsilon_y=\frac{1+\lambda}{E}\left[S_y-\lambda(S_x+S_y)\right]$$

Returning now to the compatibility equations. All terms in 10 and 11 are zero. Substituting the above expressions for ϵ_x and ϵ_y, and 27 for γ_{xy} in 9; substituting 29 in the resultant equation and clearing gives Equation 28, previously derived for plane stress.

As shown in the above, the mathematical requirements for plane stress or plane strain are the same, the satisfying of Equations 1 and 2 and 28. Also, the elastic constants are not involved. Therefore the distribution is independent of the material.

Since the relationships to be satisfied are differential equations the sum of several solutions will also be a solution. This is the theoretical justification for the superposition of stresses from different load systems to obtain the system for all loads acting together.

Solution by Stress Function

The preceding section demonstrated that a plane stress or plane strain problem in elastic theory may be solved by assuming a stress distribution, checking to see that the "stress equilibrium" Equations 1 and 2 (from Part I)

$$\frac{\partial S_x}{\partial x}+\frac{\partial v_{xy}}{\partial y}=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\frac{\partial S_y}{\partial y}+\frac{\partial v_{xy}}{\partial x}=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

are satisfied, that the "stress compatibility" Equation 28

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)(S_x+S_y)=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (28)$$

is satisfied, and that the stress system assumed, when extended to the boundary, will balance the loads at the boundary.

This method is satisfactory for checking an assumed solution, but the initial solution of a problem is helped somewhat by the introduction of a function dependent on x and y, as a parameter. Denoting such a function by $\phi(x, y)$ and relating it to the stresses by

$$S_x=\frac{\partial^2\phi}{\partial y^2};\ S_y=\frac{\partial^2\phi}{\partial x^2};\ v_{xy}=-\frac{\partial^2\phi}{\partial x\partial y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (33)$$

Substituting these values in Equations 1 and 2 shows that the function will satisfy the stress equilibrium equations whatever its form, provided only that the derivative remains finite.

The substitution of the stress values of Equations 33 into Equation 28 gives the following for ϕ to satisfy

$$\frac{\partial^4\phi}{\partial x^4}+2\frac{\partial^4\phi}{\partial x^2\partial y^2}+\frac{\partial^4\phi}{\partial y^4}=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (34)$$

The solution of the problem now resolves itself into the selection of a form for the function ϕ that will satisfy Equation 34 and the determination of the

(*Continued on Page* 106)

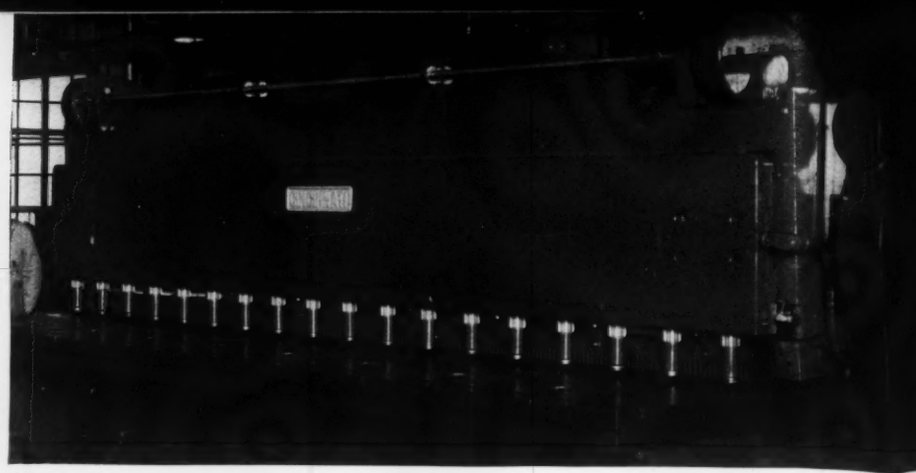
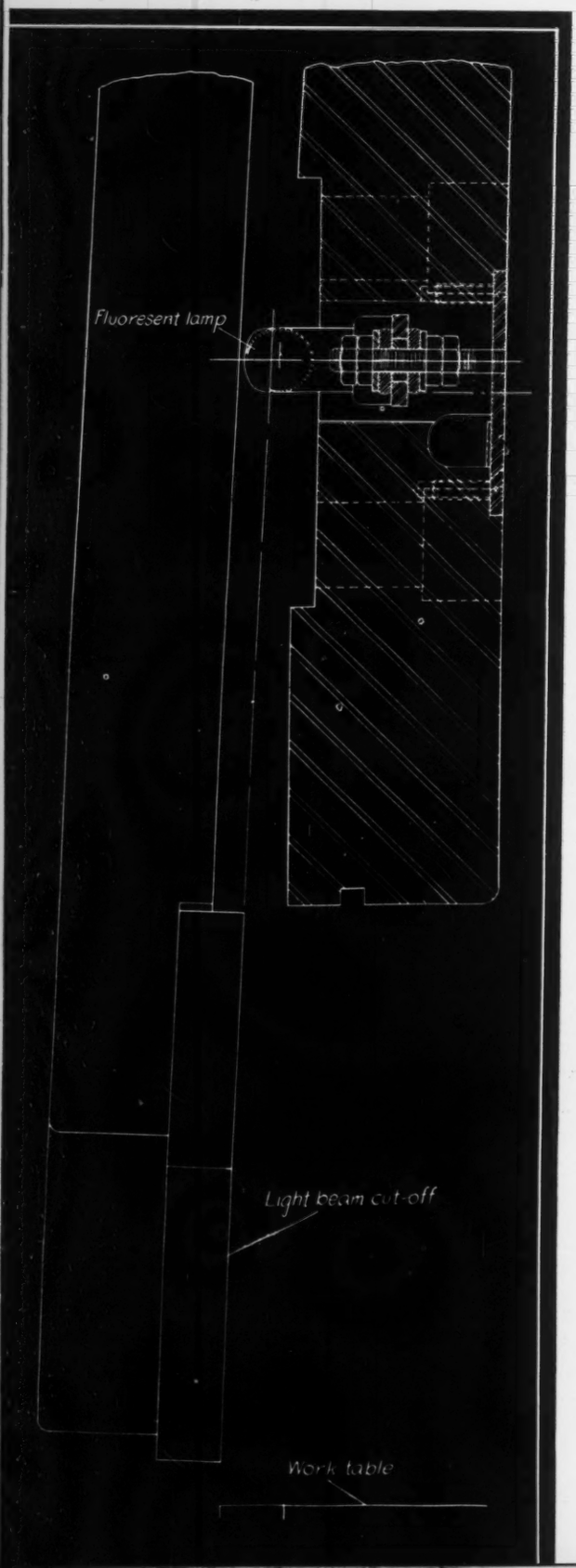


Fig. 1—Right—Built-in lighting on shear makes use of the advantages of long fluorescent lamps to concentrate light where needed

Fig. 2—Below—Cross section of mounting for built-in lamps showing method of producing sharp cut-off angle



How To Design fo

By A. K. Gaetjens

General Electric Co.

PROVISIONS for good lighting are being given increasing attention in the design of operator-controlled machines. Extensive research in the relation between lighting and seeing has indicated the desirability of illumination of 100 footcandles or greater to obtain most efficient operation with minimum fatigue. In most industries today, however, it is neither practical nor economical to obtain such illumination from general lighting systems. Consequently, good lighting practice recommends the installation of from 20 to 50 footcandles, depending upon the type of work, for the general lighting plus supplementary lighting of the immediate work area. With supplementary built-in lighting on machines it is possible to obtain from 100 to 500 footcandles of light, at the desired location, economically and practically.

Separate Lights Are Inconvenient, Unsightly

When lighting units are built direct into the machine, appearance and convenience are improved over machines with units mounted on arms which must be adjusted frequently. Lamps such as the small fluorescent lamp or special tungsten filament lamps which are able to withstand vibration throughout normal lamp life, are particularly adaptable for use in lighting units recessed in a machine. For example, a unit may be contained in the hood of a grinder where it would be entirely out of the way but yet provide the necessary light. In such a unit equipped with a gasketed cover plate no dust or dirt can penetrate it, and the smooth glass cover plate can be cleaned easily.

In *Fig.* 1 is shown an unusual application of built-in fluorescent lighting on a Cincinnati shear. Not only is the working area illuminated but, through the use of a cut-off angle, a sharp shadow produces a light beam gage. As shown in *Fig.* 3, the bright and dark areas are clear and distinct and obviate the necessity of sighting from the end or some other equally inconvenient way in attempting to set a scribed line under the shear blade. Methods employed in this interesting installation of fluorescent lighting are shown clearly in the drawing at the left, *Fig.* 2.

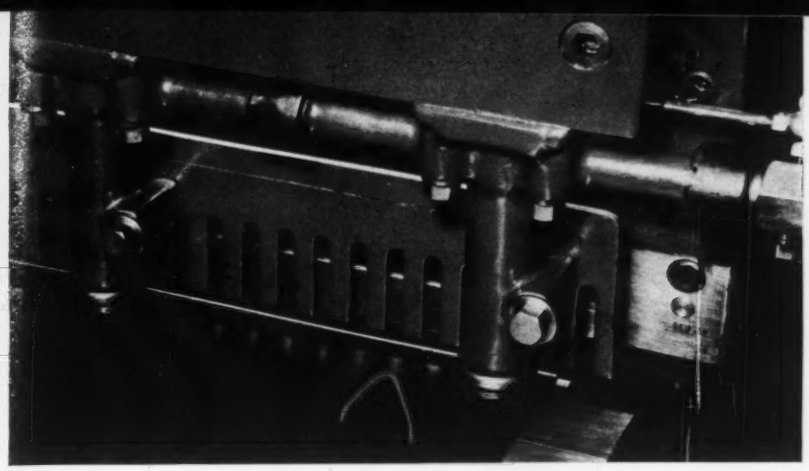


Fig. 3—Sharp cut-off gives effect of light beam gage to assist operator in setting to a scribed line

fodequate Built-in Lighting

In designing built-in lighting, a number of points must be considered. The lamp size, design of reflector, position of reflector cavity with respect to the surface to be illuminated and reflection from adjacent surfaces will affect the quantity of light which is obtained. Temperature built up by the wattage of the light source frequently is a problem. However, particularly for the illumination of metallic surfaces, the physical size of the light source and its position relative to the surface are of primary importance in obtaining high visibility of the details of that surface. These elements have received but little consideration in the past, yet probably affect the seeing value of a lighting application more than any other single factor. The report "Lighting for the Machining of Small Parts" prepared by the Illuminating Engineering Society first emphasized the importance of this approach to the problem. The accompanying charts have been derived from the data contained therein. Also, *Figs.* 5 and 6 were obtained through the courtesy of the society.

Relation between the width of a light source and the width of its reflected image upon a plane specular surface is shown in *Fig.* 4. This necessarily must be worked out in cross sections and can be applied to dimensions normal to the view of the eye or parallel to it in order to get the necessary dimensions of the light source. The chart is based upon the physical relation between the size of a light source and its reflected image in a plane specular surface (straight line cross section) with the eye 14 inches above the surface. This would be useful, for example, in illuminating a scribed block in which a die is to be milled.

The other chart, *Fig.* 5, shows the relation between the reflected image of a light source and the size of its reflection upon a convex specular surface with a circular cross section when the light source is directly above the surface. The chart is made in two parts. The left part has for its abscissa the desired size of the reflected image. Two scales are used to magnify the scale in the lower section, which would be used frequently for instruments with micrometer readings or other surfaces with small radii. The ordinate is in degrees of the angle at the point of work which is subtended by the light source. The lines as marked are for various diameters of the surface under consideration. Usually it is a cylindrical surface although it can be any convex surface circular in section.

Placed at the right of this chart to effect one com-

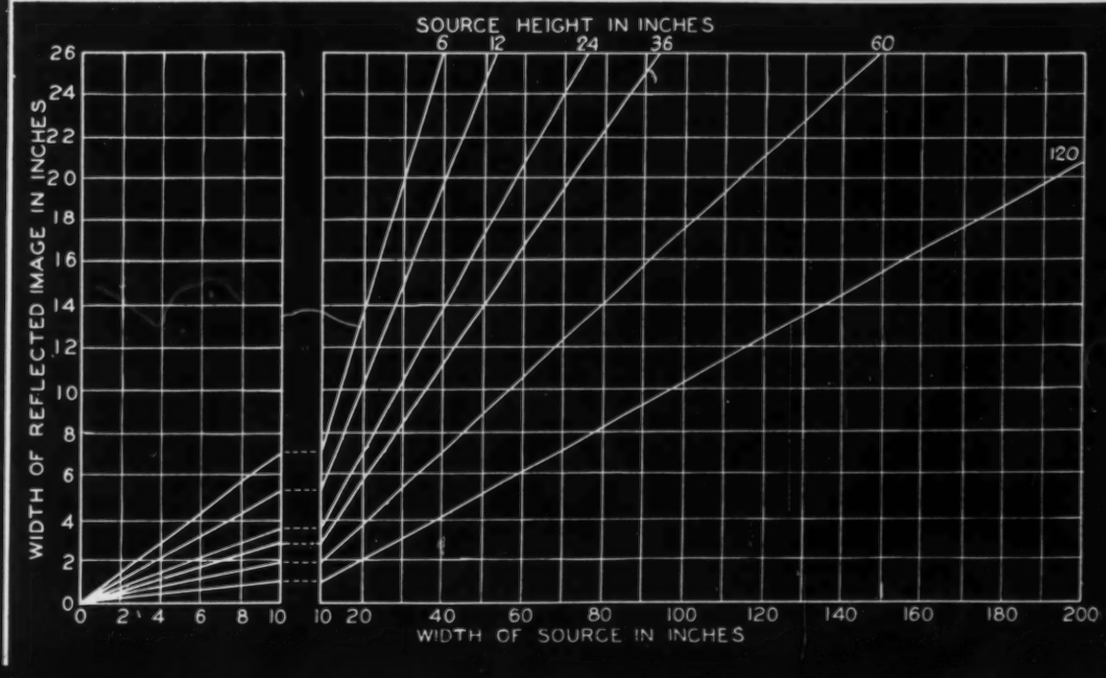
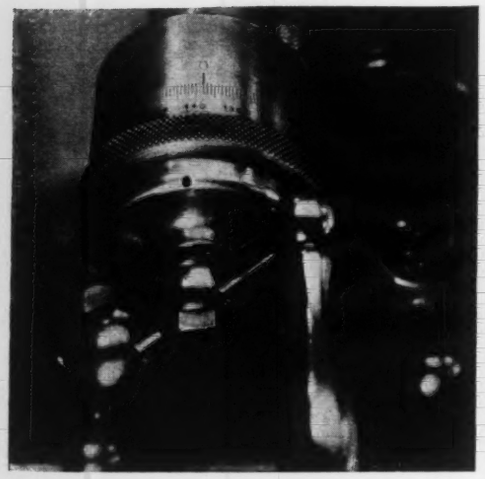


Fig. 4—Relation between the size of a light source and its reflected image in a plane specular surface with eye fourteen inches above the surface



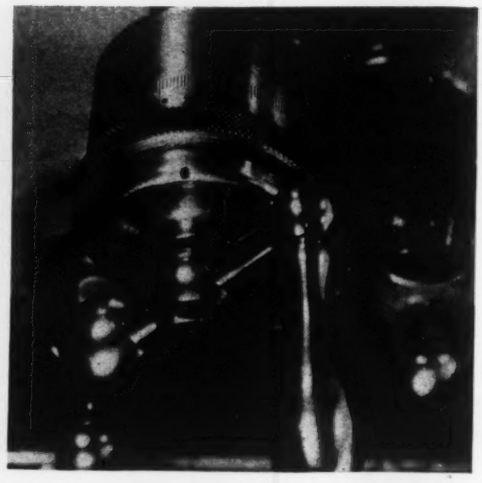


Fig. 5—Left—Appearance of a graduated collar with conventional overhead lighting. This type of lighting produces eyestrain because of narrow streaks of bright areas

Fig. 6—Adjacent—Care has been taken to illuminate the micrometer dial adequately by providing a sufficiently wide band of illumination

plete chart is a second part having for an ordinate the same source angles. The abscissa shows width of light source in inches, and the various lines are for different mounting heights of the light source above the point of work as indicated. These curves hold true only for light sources directly above the point of work. In other words, the center of the light source must bisect the source angle which it subtends. If the light source is offset, a somewhat larger source is obviously necessary for the same subtended angle. Not many cases, however, will require such an extremely rigorous use of the chart. Usually it is desirable to obtain a reflected image of the source which is considerably larger than the minimum necessary for seeing the detail.

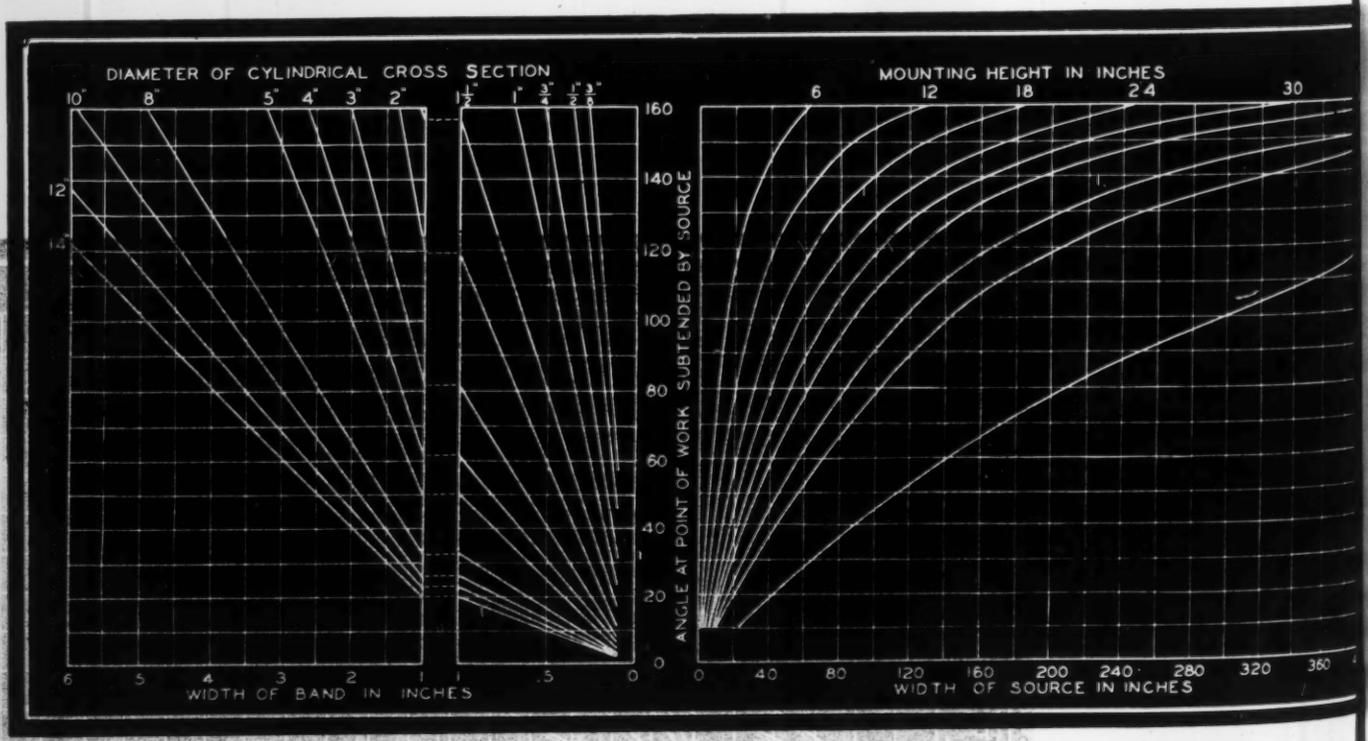
Approximately the same relation holds for a concave specular surface. With a normal viewing distance of 14 inches or more, the overall results are approximately the same as for convex surfaces.

These charts can be used only to determine the dimension of the light source in the plane of the cross section. Thus, for a cylinder it would be necessary to use *Fig.* 5 for the dimension of the light source which is normal to the axis of the cylinder and *Fig.* 4 for the dimension of the light source which is parallel to the axis of the cylinder.

Also, it is seldom that absolutely specular surfaces are found in practice. For this reason, these charts are an approximation of the results which will be obtained. The satin, somewhat off-specular finish which is usually found on the surface of scales and dials will spread this reflection somewhat and, therefore, improve the overall picture. However, the charts are necessary to obtain some idea of the results that are desired.

Suppose, for example, a light source 18 inches above the work is required to illuminate an area 3 inches

Fig. 7—Relation between the size of a light source and it reflected image in a convex specular surface when the light source is directly above the surface being illuminated


DIAMETER OF CYLINDRICAL CROSS SECTION
10" 8" 5" 4" 3" 2" 1½" 1" ¾" ½" ⅜"
12"
14"
6 5 4 3 2 1 1 .5 0
WIDTH OF BAND IN INCHES
ANGLE AT POINT OF WORK SUBTENDED BY SOURCE
160 140 120 100 80 60 40 20 0
MOUNTING HEIGHT IN INCHES
6 12 18 24 30
0 40 80 120 160 200 240 280 320 360
WIDTH OF SOURCE IN INCHES

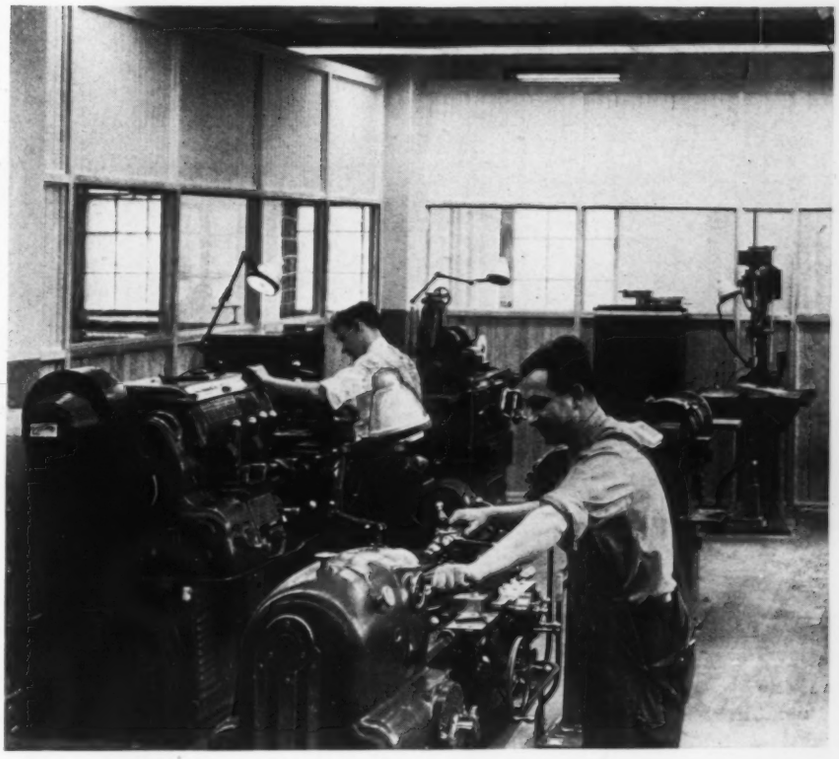


Fig. 8—Well-designed bracket lighting. Larger light source is provided. Cover glass keeps reflector efficient

wide on a 10-inch cylinder. The left-hand chart in *Fig.* 5 gives an angle of 80 degrees at the point of work subtended by the light source. Reading over to the right-hand chart on the 80-degree ordinate gives a 30-inch width of source for a mounting height of 18 inches.

Critical seeing is required on machine tools for reading graduated dials. Being fixed in position, several light sources can be utilized for best visibility. The words "several light sources" may seem overdone, yet an average of twelve and one-half lamps are used on an automobile the value of which is much less than that of a production or commercial machine.

For graduated dials and similar points requiring special lighting the following points should be considered: Dials and collars reflect light much as a mirror does. Being convex, they also pick up light from an extremely wide angle and reflect it as a comparatively narrow band on the surface of a graduated collar. For example, with a conventional lighting system overhead and no supplementary lighting of the proper type the collar has an appearance to the eye similar to that in *Fig.* 5. Because the area between the streaks of light is extremely dark by comparison, visibility throughout this region is low. It is decreased even further because of the reflected glare of the bright streaks which are annoying and produce eyestrain.

With most types of graduated dials (of small radii—½-inch or less) it has been found that a light source subtending an angle of approximately 100 degrees at the center radius of the collar being lighted will provide a sufficiently wide band on the collar so that no glare is experienced. For convex dials of larger radii, a light source subtending a somewhat smaller angle is often adequate although it is seldom that it can be reduced to less than 50 degrees. The band is sufficiently wide so that all of the detail which must be seen is in effect silhouetted against a bright background. The characters to be seen, therefore, appear very much as they would on a well printed page. Visibility is not only high but fatigue is decreased to the vanishing point. *Fig.* 6 shows such a situation where care has been taken to use a light source of sufficient length to satisfy this condition. Fluorescent lamps are well suited for this service since it is necessary to have length only at right angles to the axis of the collar, and a much smaller dimension parallel to the axis can be tolerated.

Dissatisfaction is frequently expressed for the types of supplementary lighting units now in common use. They usually consist of shallow half shades, which may shield the eye of the workman from the bright lamp but do not necessarily shield his neighbor's. In addition, the value of the shades as reflectors is often practically nil. There are available commendable supplementary units, however, designed so that the sides of the reflector adequately shield the lamp and so that cover glass protects them against oil, fumes, or dirt. Such units, as illustrated in *Fig.* 8, are now being used extensively.

Occasionally it is not convenient to put a light source at the point where needed. Often in such a case a porcelain-enamel plate of high reflecting value can be placed effectively at that point to illuminate the required object uniformly with similar results to those obtained from an actual light source.

Reflecting surfaces have other advantages which make their use worthy of consideration in spite of their lower efficiency. They are both easier to keep clean and, with the light source itself remote, heat does not affect the workman nor possibly expand the work or the machine.

Present trends toward improved appearance, more operator convenience, more exacting workmanship and increased production indicate that lighting soon will receive even more attention from the machinery manufacturer. The charts presented in this article indicate graphically the relations between the seldom considered factors of good lighting beyond foot candle levels alone and will be useful in initially laying out built-in lighting in the original designs of machines.

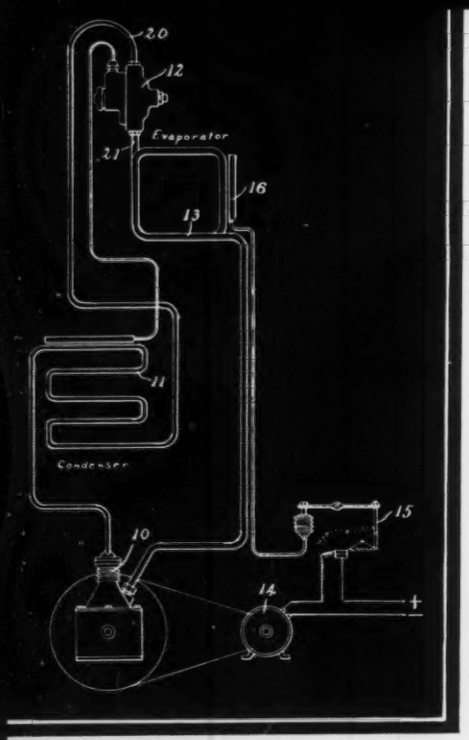


Fig. 1—Schematic diagram of refrigerating system involving a new patentable combination of elements

Consideration of Public

By George V. Woodling

REALIZING that the Patent Office operates to guard the interests of the public, an inventor—in endeavoring to obtain a patent—is confronted with the problem of drafting his claims to avoid making them broader than his invention. The conclusion reached, resulting from bargaining between the inventor and the Patent Office, should give the inventor protection commensurate with his contribution to the art. To extend his protection beyond this point would tend to discourage further experiments by others, and thereby violate the general purpose of the patent laws which are designed primarily to promote the progress of science rather than to reward the inventor.

It may be said, therefore, that the claims in a patent are each a definition of the invention as modified by a consideration of the rights of the public. They involve something more than mere compliance with certain rules of definition which define the invention in an abstract sense or by the objects or results to be obtained. Because patent claims must take into account consideration of the public, several types of claims have been the subject of legal controversy and decisions giving rise to certain rules in the drafting of claims. Several of these are discussed in the following:

MERE RESULT OR FUNCTION: A valid claim cannot be drawn to cover a mere result or function. This rule is based primarily upon the public policy which prevents the inventor from monopolizing a certain field so as to obstruct the development of the art. The claiming of the function or result is not the same thing as claiming the invention itself. For example, so far as a pure logical definition is concerned, a claim for the first television device could read:

> I claim as my invention:
> Means for transmitting visual images at distances.

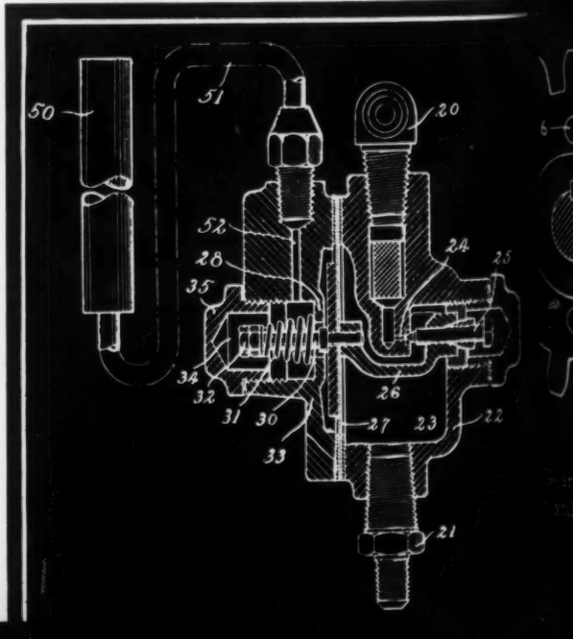
This claim is bad because it does not consider the question of public policy. It sets forth a "single means" plus a statement of the function for accomplishing the desired result. In patent language a claim of this nature is referred to as a "single means" claim. Its extension is broad enough to embrace all possible ways "for transmitting visual images at distances." If such a claim were enforcible, it would dominate all future inventions accomplishing this same result, even though different means were used. Subsequent inventions in the field would be unduly stifled rather than encouraged.

MEANS-COMBINATION: To comply with the public policy consideration, a claim must set forth the combination of means which represents the invention. While a single means plus a statement of the function when used alone, as in the preceding example, is bad, yet when two or more such statements define the function of each of the several indispensable elements of a combination, then the claim is good. The result is referred to as a "means combination" type of claim.

Drafting of such a claim may be illustrated in connection with the refrigerant control system and valve assembly shown in *Figs.* 1 and 2. The compressor 10 circulates refrigerant through a closed circuit including the condenser 11, the valve assembly 12 and the evaporator 13. The movement of the valve plunger 25, see *Fig.*

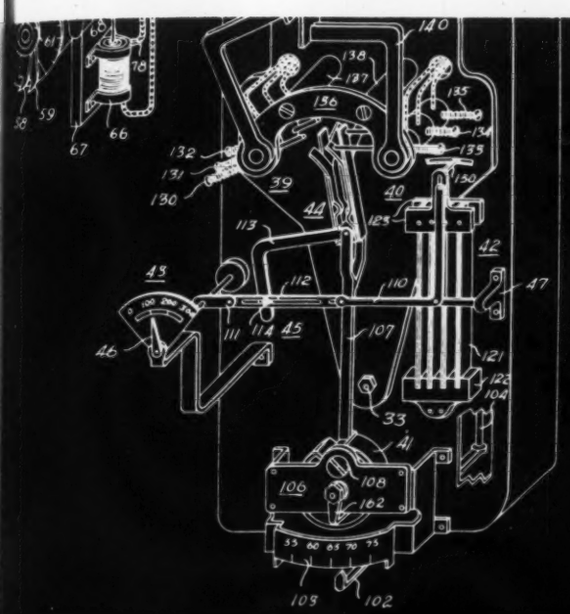
Fig. 2—Detail of valve shown in Fig. 1. Patent claims covering the invention are means-combination type.

Fig. 3—Claims illustrating careful selection of wording meeting strict requirements of courts. Balance has been struck between inventor's and public's rights

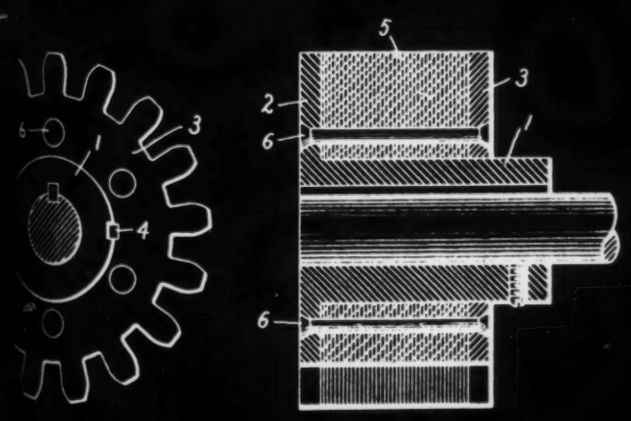


Copyright, 1941, George V. Woodling

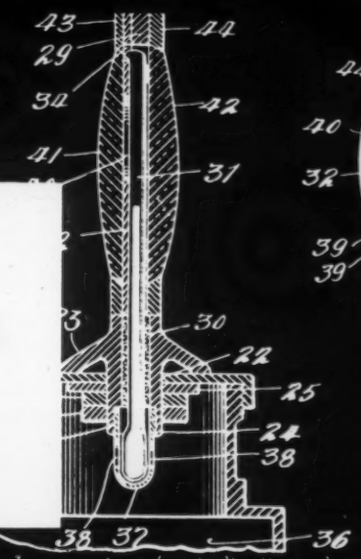
s Obtain Patents

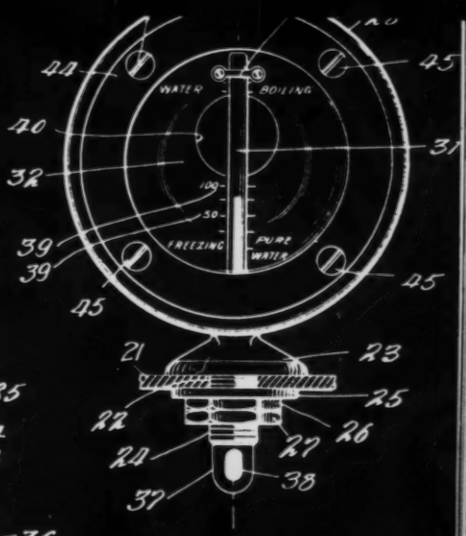


eans for giving a measurement of the effective temperature mprising, a hygroscopic humidity element, a temperature sponsive element, means operated by said elements, the rangement of the hygroscopic humidity element, the mperature responsive element and the means operated by d elements being such that the rate at which the hygro pic humidity element influences the movement of said ens is greater at higher temperatures than at lower mperatures and that the value of said measurement lies tween the value of said measurement lies between the ue of the dry bulb temperature and the wet bulb mperature.

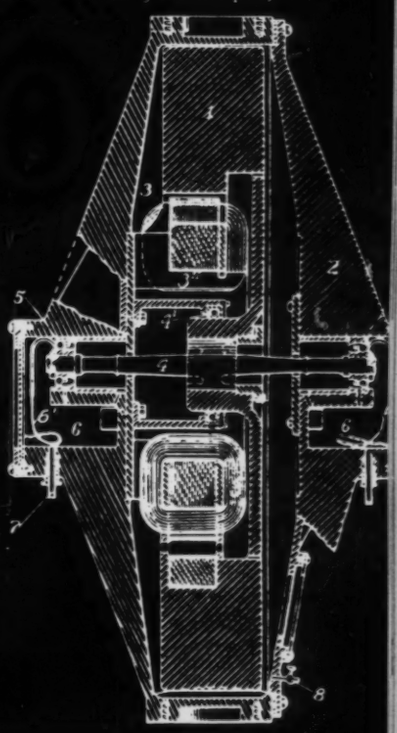


r having a toothed body part composed of spinnable xtile fibers



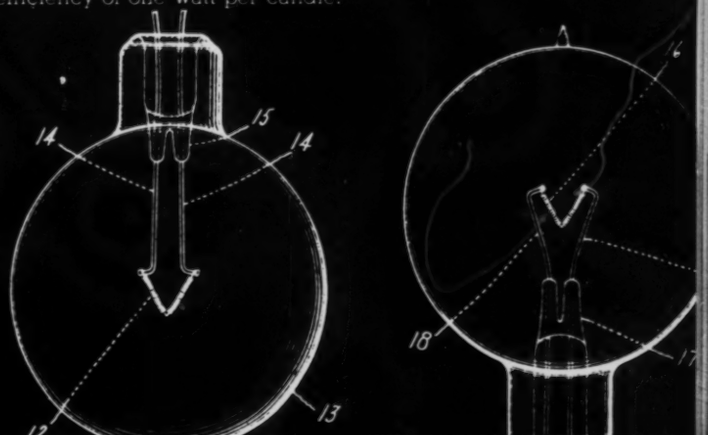


In a system for indicating abnormal conditions in an internal combustion engine provided with a liquid circulation cooling system for the cylinders of the engine, said cooling system including a radiator having an air space therein above the level of the circulating liquid, the combination with the radiator of an indicating device normally permanently carried by said radiator and comprising a thermometer having a bulb normally located in said air space at the top of the radiator and having an outwardly projecting visible tube, and a protective casing for the projecting portion of said tube.



A gyro navigation apparatus comprising a gyro wheel, means whereby said wheel is mounted to spin on a normally horizontal axis and to move about a second horizontal axis at a substantial angle to the spinning axis and also to move about a vertical axis, and means for restraining the free movement of said gyro, said means being adapted to exert a compound torque on said gyro relative to such second horizontal axis and the vertical axis.

In an incandescent lamp, the combination of the closed lamp bulb, a gaseous filling therein of substantial pressure at the operating temperature of the lamp and of substantially poorer heat conductivity than hydrogen, and a filament of such high melting point and low vapor pressure that it may be operated during a long useful life at a temperature higher than that of a tungsten filament operating in a vacuum at an efficiency of one watt per candle.



2, is responsive to the pressure of the refrigerant acting upon the diaphragm 27. Pressure of the expansible liquid in the thermal bulb 50 also influences the diaphragm 27 and thus modifies the movement of the valve plunger. An analysis reveals that the invention or system has three main functions:

1. Means for circulating a refrigerant through an evaporator including a condenser
2. Means responsive to the pressure of the refrigerant in the evaporator for controlling the flow of refrigerant to the evaporator
3. Means thermally associated with the condenser for influencing the action of the controlling means.

Therefore, a means-combination type of claim may be drafted reciting these three functions, thus:

> I claim as my invention:
>
> 2. Refrigerating apparatus comprising in combination an evaporator, means for circulating refrigerant through the evaporator including a condenser, means responsive to the pressure of the refrigerant in the evaporator for controlling the flow of refrigerant to the evaporator, and means thermally associated with the condenser for influencing the action of the controlling means.

In a means-combination type of claim, the invention does not ordinarily reside in the particular structure of the individual parts, but in the way the several parts co-operate as a patentable unit. Since it is the unit which is the subject matter of the invention, it does not matter whether or not each of the parts is old in itself such as, for example, "means for circulating (compressor) refrigerant through the evaporator including a condenser," as recited in Claim 2.

Considerations Involving New Part

When the gist of an invention resides primarily in creating a new part, as for example the valve assembly in *Fig.* 2 which is to be used in combination with one or more old parts, there appears to be a division of authority as to whether the new part may be recited as "means plus a statement of function" along with the old parts in a "means-combination" type of claim. The division of authority results principally from the view taken on the question of public policy. Decisions of the Patent Office and the Courts which favor the inventor's point of view, permit the new part to be recited as a "means plus a statement of function" along with the old parts of a "means-combination" type of claim. Thus, the Claim 2 favors the inventor's point of view. Other decisions, which emphasize the interest of the public, point out that the new part, for example the valve assembly, must be set forth *structurally* in the claim in order to limit the scope of the inventor's protection. In the following Claim 3, the valve assembly is set forth structurally and leans in favor of the interest of the public.

I claim as my invention:

> 3. Refrigerating apparatus comprising in combination an evaporator, means for circulating refrigerant through the evaporator including heating dissipating means arranged to increase in temperature when refrigerant is circulated, a valve for controlling the flow of refrigerant to the evaporator, a diaphragm responsive to the pressure in the evaporator for moving the valve in one direction, a spring for moving the valve in the other direction, a closed chamber surrounding the spring, a closed gas chamber thermally associated with the heating dissipating means, and a pressure-equalizing connection between said chambers.

LAW OF NATURE: Valid claims cannot be drawn to a law of nature. This rule also is based upon the consideration of public policy. The classical example of an attempt to claim a power of nature is the claim of Samuel F. B. Morse, inventor of the telegraph. The claim, which was involved in a suit and which was declared void by the United States Supreme Court as claiming a power of nature, reads as follows:

> I do not propose to limit myself to the specific machinery or parts of machinery described in the foregoing specification and claims, the essence of my invention being the use of the motive power of the electric or galvanic current, which I call "electro-magnetism" however developed for marking or printing intelligible characters, signs, or letters at any distances, being a new application of that power of which I claim to be the first inventor or discoverer.

Combining Laws of Nature

A process which utilizes *several* laws of nature, however, and which claims the entire process is patentable. The foregoing claim of Morse was held invalid because he sought a patent on a *single* power of nature—the motive power of electric current developed for printing characters at a distance. If a patent for a single power of nature were granted and sustained, it would be much broader than a patent for a process utilizing several powers of nature, because it would cover all processes which aim at the same result and which use that single power of nature, no matter in what combination the single power of nature may be used with other laws.

Furthermore, if a patent for a single power of nature were sustained, it would encourage inventors to guess at certain laws of nature, and if they guessed correctly, they could claim that power of nature and suppress all subsequent processes using it.

Public policy also demands that the claims be definite. By this is meant that a claim should so define the invention that little confusion can arise in the minds of those who are skilled in the art as to what the claim covers or protects. In the selection of words, the applicant is free to choose those which he thinks best describe his invention, provided he uses them consistently throughout the claims of his patent.

Prosecution of claims in the Patent Office to comply with considerations of public policy and to meet the strict requirements of the courts thereafter in infringement suits involves a delicate manipulation of words, as evidenced by the sample claims accompanying the devices shown in *Fig.* 3. These claims demonstrate the attempted balance between the inventor's rights and the public's rights in establishing fair treatment for both of the contracting parties.

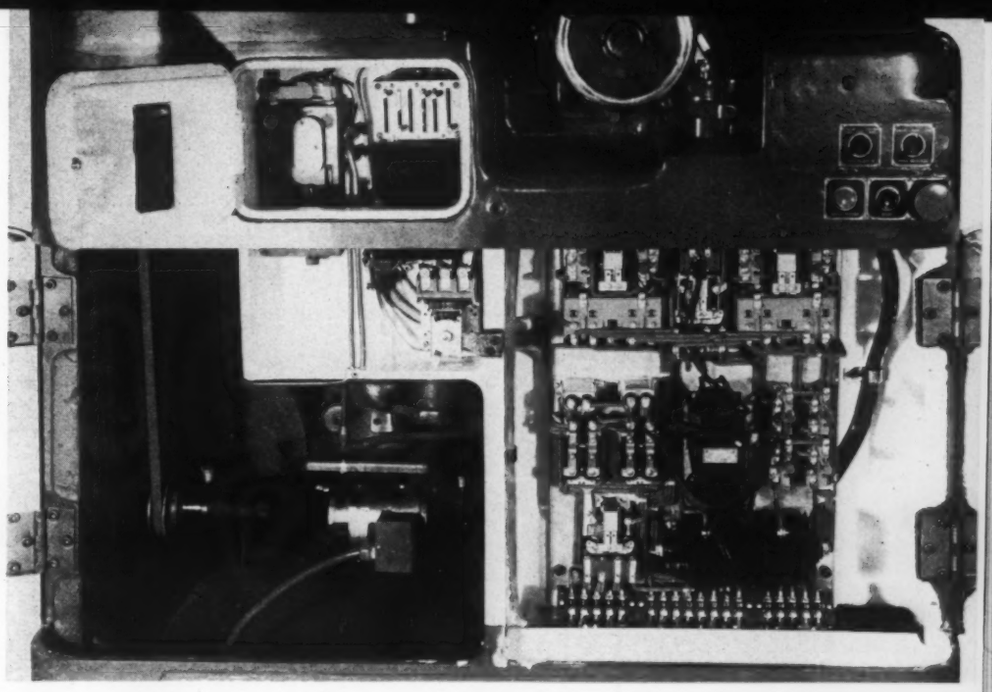


Fig. 1—Panels removed to show drive and controls for a grinder. Diagrams for the plug braking control are shown in Figs. 2, 3

By R. S. Elberty

Electrical Engineer
Landis Tool Co.

Designing Control Circuits

Part I—Control Diagrams, Construction and Use

SATISFACTORY performance of a machine depends on its control. The machine designer, therefore, must concern himself with the design of the control as well as in the various mechanical phases. He should have enough specialized knowledge of electrical control to enable him to work closely with the control engineer on the design of this important part of the machine.

Design of an electric control starts and ends with a wiring diagram. The first diagram, schematic in form, is the "elementary controller diagram." The final wiring diagram is a picture of the physical appearance of the control and includes the "controller wiring diagram" and the "external controller wiring diagram." The controller wiring diagram shows the location of the various parts and wiring on the control panel. Other electrical equipment and wiring on the machine is shown on the external controller wiring diagram.

On complex control schemes the designer should combine these diagrams in a "machine wiring diagram" to show a complete picture of all electrical equipment and wiring used on the machine. Motors, limit switches, and other equipment can be identified. Also, horsepowers, speeds, ampere rating and other

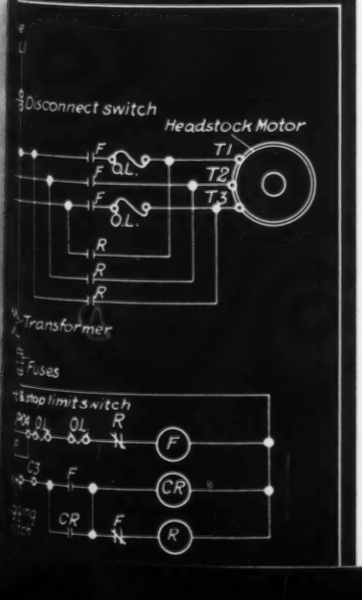


Fig. 2—Elementary wiring diagrams for plug braking control illustrate the four classifications of electrical equipment: Contacts, conductors, operated members and conversion devices

SIMPLIFIED and standardized wiring diagrams are important in developing the best control circuit for a machine in a minimum time and are discussed in this article with respect to types, drafting and uses. Symbols, markings and rules are included to facilitate making and reading of diagrams. The article serves also as an introduction to a newly developed "Control Criterion" by which a designer can determine readily whether or not a control has sufficient, too few or too many parts for proper operation. The criterion will be published in succeeding issues and is applicable to mechanical, pneumatic and hydraulic controls as well as electrical.

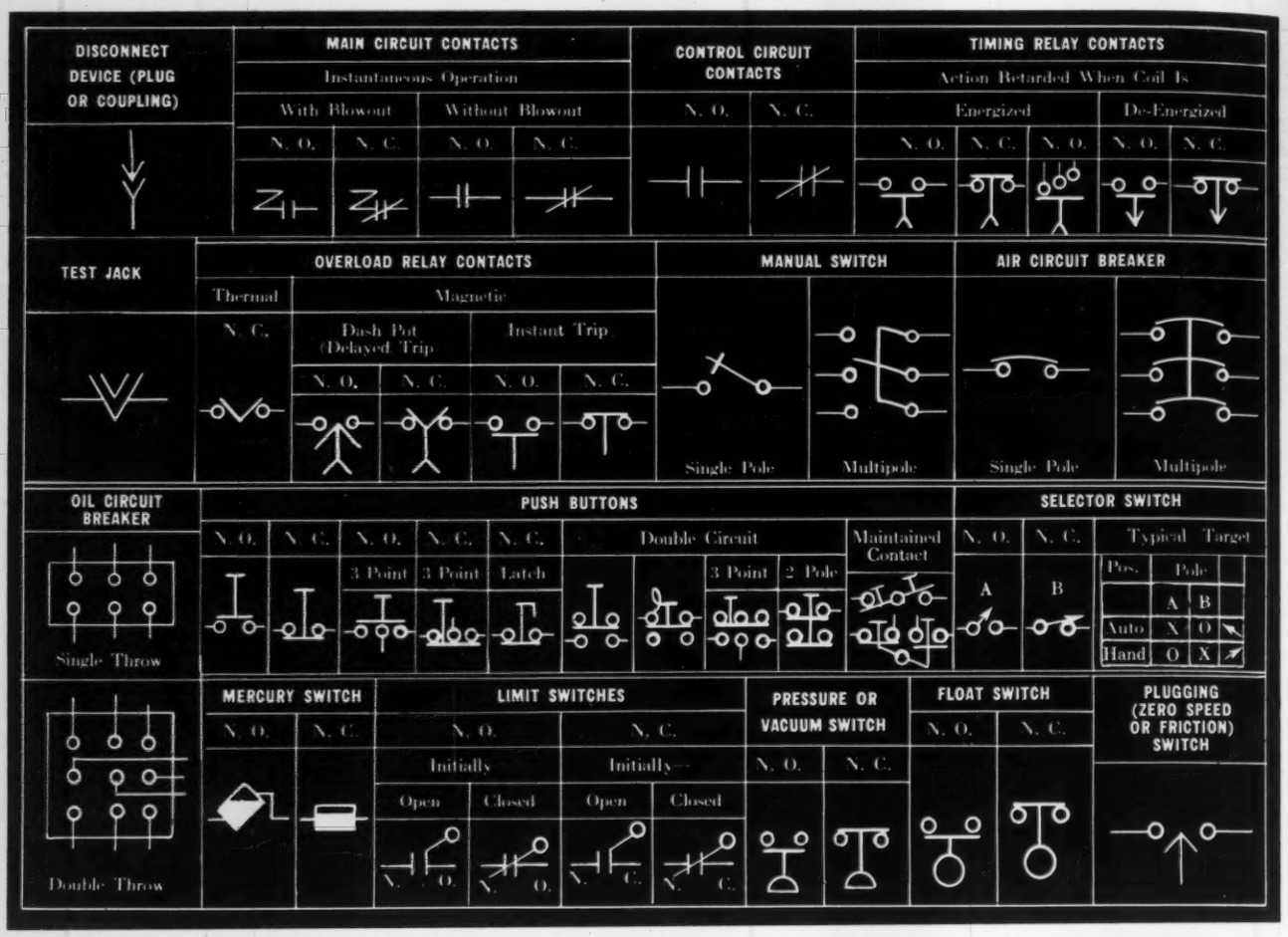


Fig. 3—Symbols for contacts for controller diagrams

ratings can be noted on the drawing. Wire size, color and length can be specified, conduits and fittings can be shown. The machine wiring diagram can therefore be extended to show complete information on the mounting and wiring of all electrical equipment used on the machine. Users of the machine need this machine wiring diagram for electrical maintenance. Electrical additions or changes to modify the cycle of operation can easily be noted if the machine wiring diagram is complete.

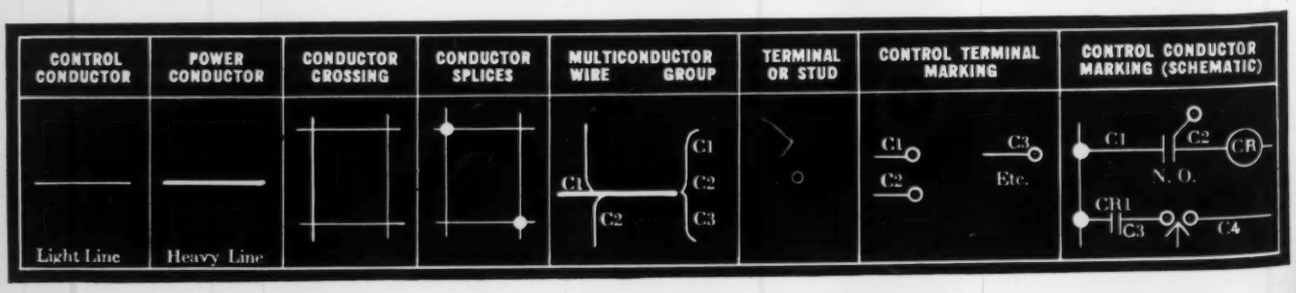
Electrical parts shown on the elementary controller diagram are located according to their function and without reference to their physical location on the control panel or on the machine. A relay coil may be shown in its correct electrical position and be far removed from the contacts operated by it. The coil and contacts must be numbered to identify them as belonging to the same piece of apparatus.

Once the difference between elementary and conventional diagrams is understood, the elementary diagram becomes easily read and constructed. Here is a common meeting ground between the machine designer and the control engineer. The operation of the control and possible modifications of the machine cycle are clearly shown on the elementary diagram. Besides its value to machine designers and control engineers, maintenance electricians find the elementary diagram useful in determining the type of electrical trouble should the machine fail to function properly.

While equipment for machinery electrification has many varied forms, all such apparatus falls into four classifications: Electrical *contacts* establish the conditions of the circuits, *conductors* carry the electrical energy, *operated members* change electricity into other forms of energy, and *conversion devices* change electrical energy into more useful forms. The wiring diagrams show these various electrical items. Machine wiring diagrams stress the location and connections, while the elementary controller diagrams emphasize the functions of the equipment.

As examples, an elementary diagram and a machine wiring diagram for the race grinder electrical drive and control illustrated in *Fig.* 1 are shown in *Figs.* 2 and 6, respectively. Contacts illustrated from left to right in *Fig.* 1 are sizing device contacts, timer contacts, main disconnect switch, relay and main contactor contacts on the panel, and pushbutton and selector switches. Machine and panel wiring is shown. The work drive motor, timer motor, and contactor coils constitute operated members; while the capaci-

Fig. 4—Wire and terminal symbols for use on diagrams



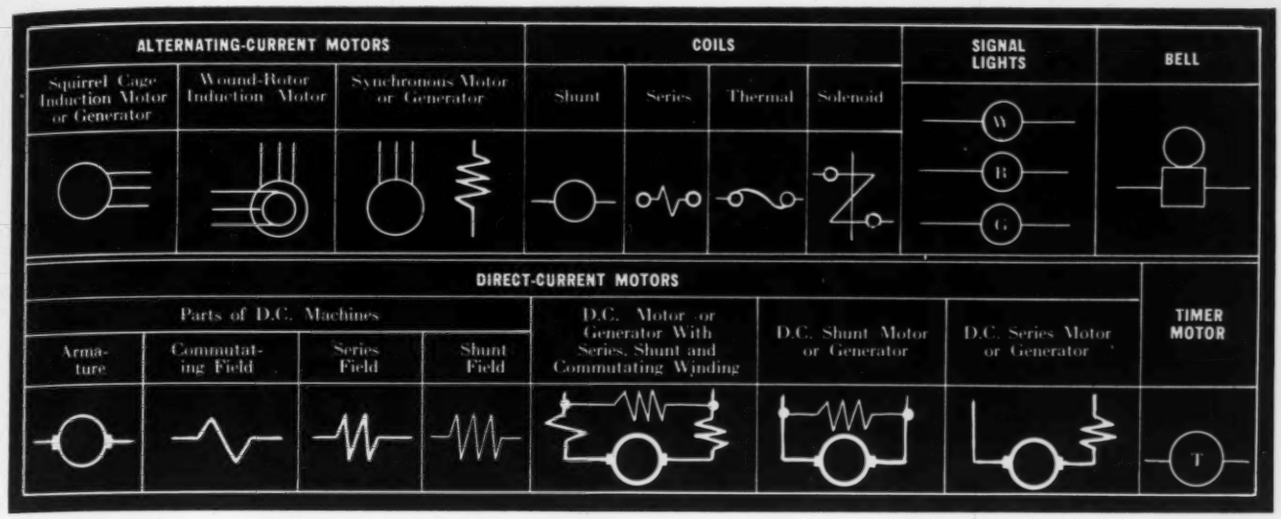


Fig. 5—Operated members are indicated by these symbols in controller diagrams.

tors, transformer, and rectifier are conversion devices.

While there are no complete standards for the preparation of wiring diagrams, there is no need to make them more complicated than necessary. To avoid confusing differences between methods of drawing controller wiring diagrams, machine designers have a right to ask for a greater degree of uniformity in these drawings. The following suggested rules are generally followed and might well be adopted as standard by designers and control engineers.

(1) All equipment should be shown in the approximate positions as mounted on the machine and the control panel

(2) Contacts should be shown in power off position; pushbutton and limit switches, in position before machine is started

(3) Wires should be shown in actual positions on panel and machine. For "front-of-board" panel wiring, wires should be shown as the front view of the panel. If the wires are on the back of the panel, the diagram should show the rear view of the panel. The diagram is easier to read for front-of-board wiring

(4) Panel wiring should be indicated as dotted lines to differentiate it from machine wiring which should be shown as solid lines

(5) Heavy lines should be used for power wiring, light lines for control wiring

(6) If there are wires enough to be confusing, they should be grouped in one line. This could well be a double line instead of the freehand cross-hatched line often used.

The elementary diagram forms the basis for designing the control. In this diagram, it falls upon the machine designer to standardize on good practice for control design. Diagrams can be simplified and faults in design can be avoided by consideration of the following rules for the construction of elementary diagrams.

(1) Standardized symbols and markings should be employed as, for instance, shown in the illustrations

(2) Every item required by the control and machine should be shown on the diagram

(3) Drawings should not be crowded

(4) Power wiring, contacts and motors should be at top of page

(5) From left to right on the elementary control diagram should be shown (a) line 1; (b) pushbuttons, selector switches and other manually operated contacts; (c) machine-operated contacts such as pressure switches, limit switches and timer contacts; (d) control contacts mounted on the panel such as magnetic and overload relay contacts; (e) operated members such as contactor coils, solenoids and indicating lamps; and (f) line 2.

The "sneak circuit" has caused many sleepless nights among control engineers who should welcome Rule (5) for elementary diagrams. By firmly tieing all operated members to the right-hand line in the diagram, the designer insures that electric current can pass through these units in one direction only, thereby eliminating a common cause of sneak circuit. This practice has the added advantage that all control contacts are at the same potential, preventing short-circuits and limiting the severity of electric shock from pushbutton or master switches. Mixing up a controller will not give a reduction in the

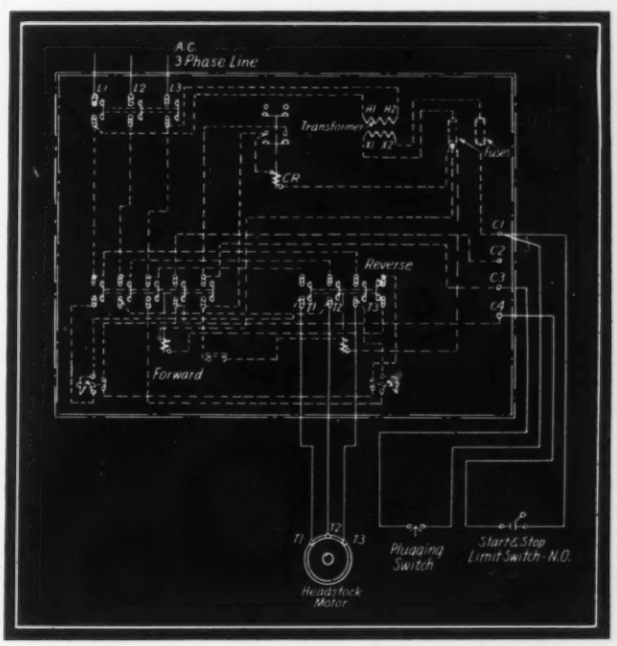


Fig. 6—Complete panel and machine wiring diagram showing a plug braking control as applied for headstock drive on a grinder. Being a two-wire control circuit, low voltage protection is not provided, obviating terminal C2

Standard Control Device Markings

Armature Acceleration	A	Field Protective (Field Weakened at Standstill)	FP	Lowering	L
Armature Shunt	AS	Field Reversing	FR	Low Speed	LS
Aux. SW (Breaker) Normally Open	a	Field Weakening	FW	Low Torque	LT
Aux. SW (Breaker) Normally Closed	b	Final Limit—Forward	FLF	Low Voltage	LV
Balanced Voltage	BY	Final Limit—Reverse	FLR	Master Switch	MS
Brake	BR	Final Limit—Hoist	FLH	Maximum Torque	MT
Compensator—Running	MR	Final Limit—Lower	FLL	Middle Landing	MLD
Compensator—Starting	MS	Final Limit—Up	FLU	Main or Line	M
Control	CR	Final Limit—Down	FLD	Motor Field	MF
Door Switch	DS	Forward	F	Overload	OL
Down	D	Full Field	FF	Pilot Motor	PM
Dynamic Braking	DB	Generator Field	GF	Plug	P
Field Acceleration	FA	High Speed	HS	Reverse	R
Field Deceleration	FD	Hoist	H	Series Relay	SR
Field Discharge	FD	Jam	J	Slow Down	SD
Field Dynamic Braking	DF	Kick Off	KO	Thermostat	TS
Field Failure (Loss of Field)	FL	Landing	LD	Time	T
Field Forcing (Decreasing on Variable Voltage)	DF	Limit Switch	LS	Up	U
Field Forcing (Increasing on Variable Voltage)	CF			Undervoltage	UV
				Voltage Relay	VR

number of parts. A jumbled control is unsafe and unduly complicated. Rule (5) for elementary controller diagrams is important but not in general use.

For any but the simplest control, both the elementary and machine wiring diagrams are essential. About half-way through the design of the machine an elementary diagram should be drawn. As the design progresses, this diagram can be revised until the machine cycle is established. The control engineer can then design the control to determine the dimensions required. From the controller wiring diagram, the machine designer can add the external electrical equipment to form the machine wiring diagram. This diagram may be supplemented by additional drawings to show the complete application of electrical eequipment and wires to the machine in the complete design.

This discussion applies mainly to the many highly special machines in use and being designed today.

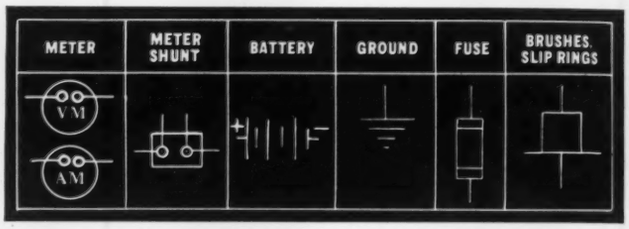
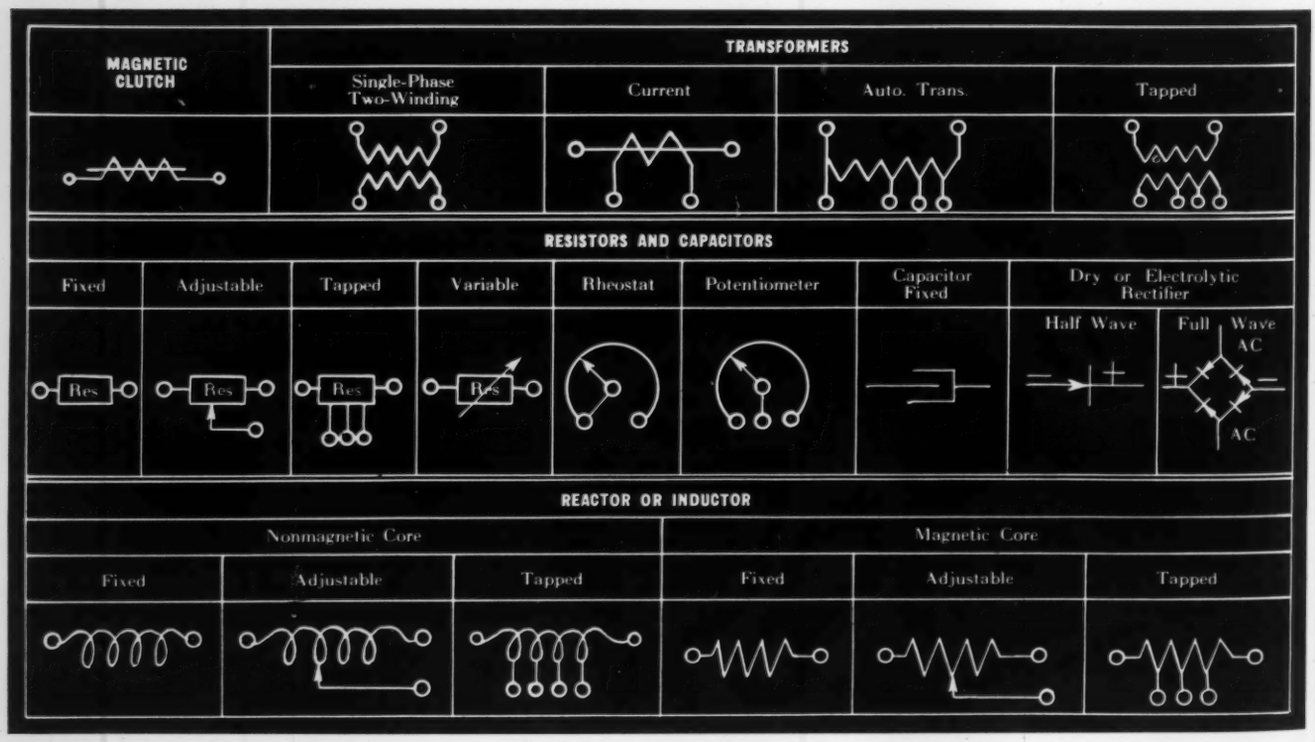


Fig. 8—Miscellaneous symbols for use in diagrams

Since the trend is toward electrically controlled automatic machines, every machine designer must interest himself in electrical control or lose out in the procession. The designer thoroughly knows the requirements of the cycle and is best equipped to work out a controller to the extent that it is functionally correct. Close co-operation between the designer and electrical manufacturer is essential, but the final responsibility for the success of the control rests with the man who designs the machine.

Fig. 7—Symbols for conversion devices used in diagrams



Selecting Special Motors

Part III—Lightweight C. M[illegible]s

By W. H. Fro[illegible]
The Dumore Co.

SPECIALLY designed lightweight fractional horsepower motors have assumed considerable importance in applications where reduction in weight is an outstanding consideration. Transportation equipment, for example, is designed with a view toward reducing dead weight and increasing payload.

Airplanes are a prime example of the importance of weight reduction in auxiliary motors and equipment. For instance, in *Fig.* 1 is shown a bomber, the cowl flaps of which are driven by a 3-pound, 1/14-horsepower motor. The designer of such equipment is constantly obsessed with the realization that every ounce of non-revenue weight he can save means an extra ounce of gasoline or an extra ounce of payload which may be carried. More fuel means more safety and more payload means less overhead.

Portable machinery is another field in which much thought must be given to weight and in this type of application the weight of the motor is again a consideration. The sale of such equipment is facilitated in proportion to its lightness of weight and resulting ease of operation and portability. This category includes portable electric tools, household appliances, and devices such as sprayers, portable projectors and cloth cutters.

Fig. 1—Bomber cowl flaps are driven by a three-pound motor at 1600 revolutions per minute

Closely related to reduction of weight is reduction of size. Many business machines, for example, have limited space requirements, and motors and other parts must be specially designed for this service. On some aircraft applications, size and weight receive equal attention. Although a reduction in one generally results in a reduction in the other it is sometimes necessary to keep both points in mind.

Increasing Speed Reduces Weight

Since the aircraft industry is probably most concerned with weight reduction a discussion of fractional horsepower aircraft motors will cover the principal points of lightweight motor design and construction. These motors have some features which are peculiar to the type of service, but the basic factors apply to motors for all applications requiring light weight.

A prime method of reducing the weight of an electric motor for a given power output is to increase the armature speed. Because power is proportional to the product of speed and torque, an increase in speed, with the torque remaining constant, will result in an

increase in power. This principle is employed in high-frequency alternating-current motors, since speed is proportional to frequency. Experiments have been conducted in the use of 400-cycle equipment on aircraft, with motors operating at 24,000 revolutions per minute, but because of the necessity of employing a separately driven alternator this system is considered economically suitable only for the largest aircraft.

Series-wound, direct-current motors have high-speed characteristics and may be wound to operate on almost any direct-current voltage. The practical lower limit is six volts and the practical higher limit, in fractional horsepower sizes is 230 volts. In small motors the clearances between live parts and ground are so small than flashovers are likely to occur on voltages higher than 230. Some manufacturers even limit the maximum direct-current voltage to less than 230. Series motors in the fractional horsepower sizes may be operated on both alternating current and direct current without any changes, the lower limit on alternating current being about 32 volts, and the higher, 250 volts.

Aircraft have for some time been equipped with a direct-current voltage supply obtained from 12 or 24-volt batteries. Just as in the automobile, batteries are the simplest and lightest power supply, and when the need for electric power for the operation of lights and starters arose they were the obvious choice. Most airplanes today, with the exception of a few of the very largest, employ 12 or 24-volt systems.

Protects Against Destructive Speed

Motors in which the armature and field are connected in series through a commutator can be wound to develop a given power output at almost any speed between approximately 1500 and 20,000 revolutions per minute. The maximum speed is determined by the amount of centrifugal force the windings and commutator will withstand. On most aircraft applications speeds in the neighborhood of 10,000 revolutions per minute are used. In some instances speeds as high as 18,000 have been used, but since the idling speed would be close to 35,000 the motor is permanently connected to load to prevent its attaining a destructive speed. It should be noted that the series motor has a varying speed characteristic; that is, the speed is approximately inversely proportional to the load.

As compared to the moderate-speed series motor, shunt motor, or 60-cycle induction motor, the high-speed series motor is extremely light. For example, a motor normally rated 1/5 horsepower at 7000 revolutions per minute for continuous duty can be wound to develop ½ horsepower at 15,000 revolutions per minute for intermittent duty. A 60-cycle single-phase induction motor developing ½ horsepower at 3450 revolutions per minute would weigh about 10 times as much as the high-speed series motor. It will be apparent, therefore, that the largest weight reductions may be obtained through the use of high operating speeds.

High-speed motors would of course be useless for many applications unless suitable means were available for reducing the speed to practical values. Motors therefore are designed with built-in gearing of various types to provide a wide range of output speeds. Frequently, however, the motor purchaser prefers to buy the motor without gears and design the gearing into his machine. Aircraft manufacturers sometimes follow this procedure, and it is general practice with portable tool manufacturers to purchase motor parts only and install them in their own housings in the interests of compactness. Gearing adds weight to the motor but even considering this increase and the loss of efficiency through the gears, the weight of the complete power unit is less than that of an equivalent low-speed motor.

On many of the more recent designs in the air-

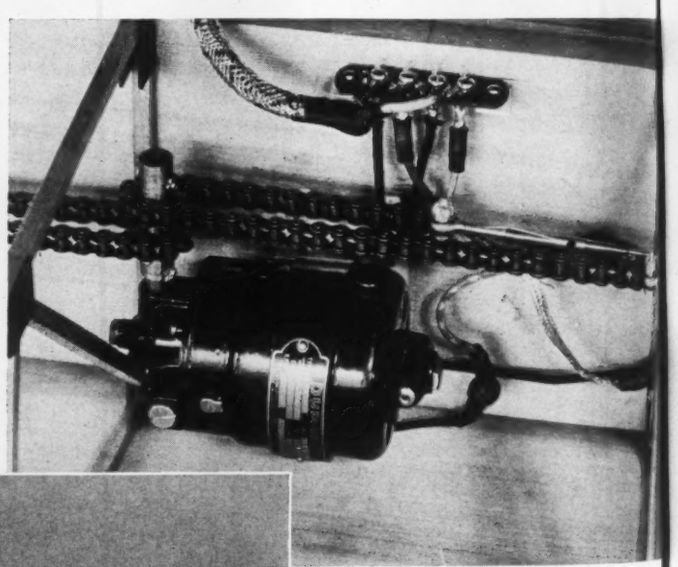


Fig. 3—Motor drive for the installation at left. Ninety-degree gear unit provides 200 revolutions per minute at shaft

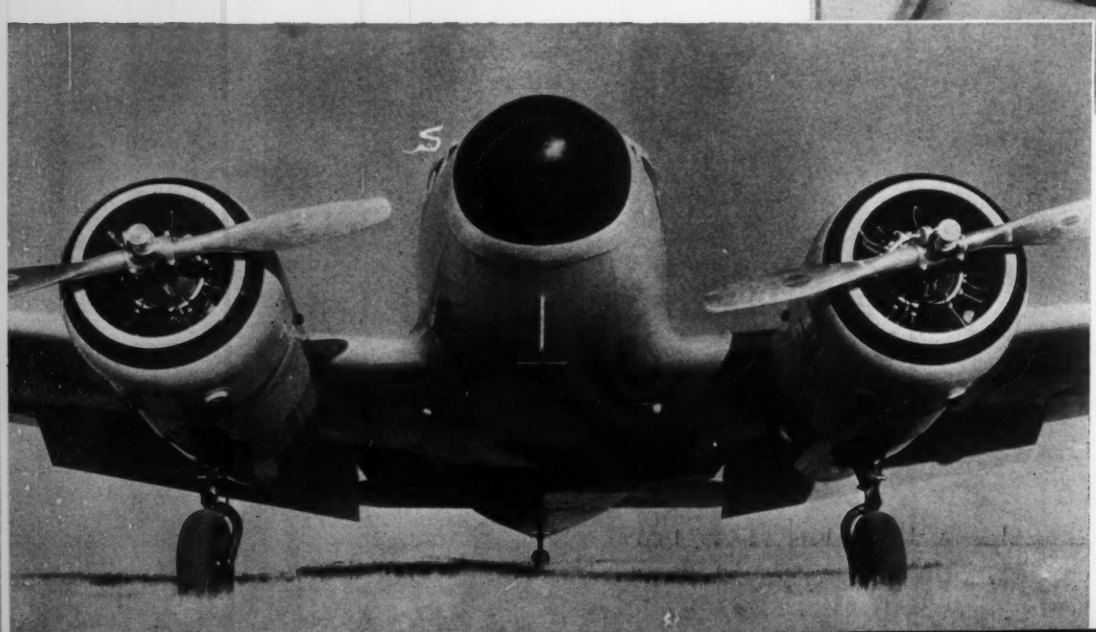


Fig. 2—Left—Lightweight, 1/20-horsepower motor controls the wing flaps on this airplane

craft field, tailor-made gear boxes are specified in the interest of light weight and compactness. Such gear boxes are designed to provide the exact speed required for a particular application and they sometimes include built-in limit switches. This procedure permits the use of a standard type of aircraft motor without the disadvantage of excessive weight sometimes encountered when this practice is followed.

Many aircraft applications, of course, require specially designed motors. Ordinary commercial types of electric motors have frequently been modified for aircraft service by winding them for 12 or 24-volt operation, but when motors have been entirely rede-

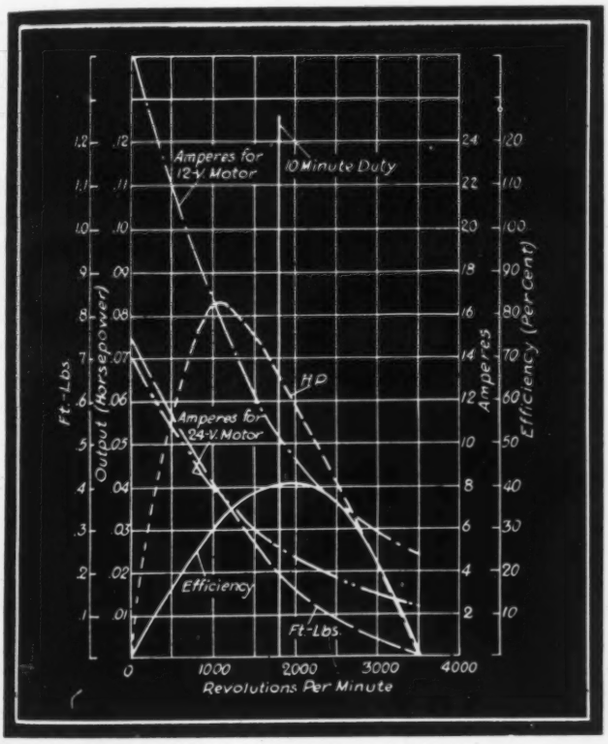


Fig. 4—Performance characteristics of 12-volt and 24-volt motors designed for intermittent duty for applications like cowl flaps and retractable landing gears

signed for weight reduction, with the particular requirements of the application kept in mind, the savings in weight have been considerable. For example, when advantage may be taken of operating characteristics, such as intermittent duty and high speed, it is possible to accomplish weight reductions of as much as 25 per cent.

Use of lightweight materials such as magnesium and aluminum are responsible for considerable reduction in weight of aircraft motors. Aluminum weighs about one-third as much as cast iron, and magnesium one-third less than aluminum. Although the structural strength of these metals is less than that of cast iron this fact is not a serious disadvantage in the case of small motors since high strength is generally not required. Magnesium offers some machining difficulties but its weight advantage is bringing it into much wider use. Special treatments are frequently used to prevent corrosion—anodizing in

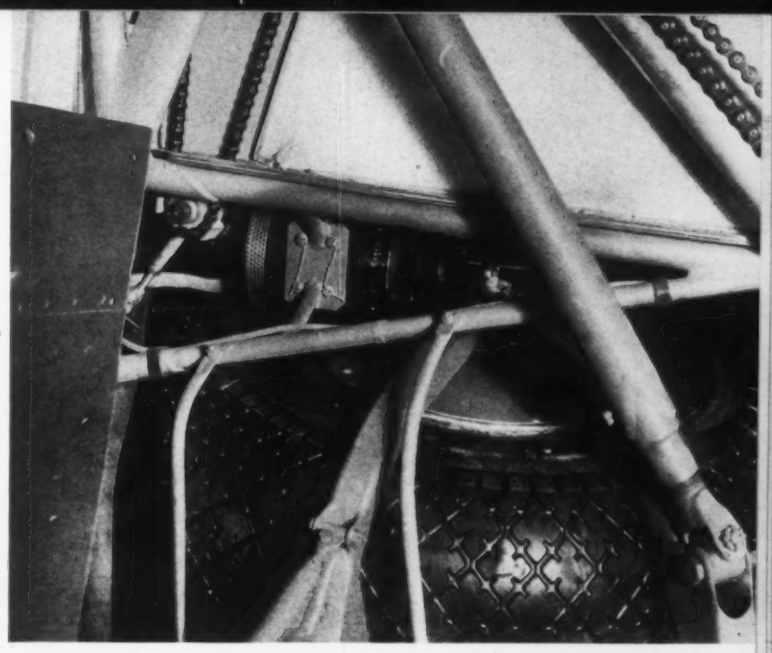


Fig. 5—Motor drive for landing gear is alongside nested landing wheel. Motor is 12 volts, direct current with worm-gear reduction, providing right-angle drive

the case of aluminum and pickling for magnesium.

Higher operating temperatures allow for reduction of weight in continuous-duty motors. The temperature rise of a naturally ventilated motor is determined by the amount of current carried in the windings and the amount of radiating surface. Temperature rise, however, is limited mainly by the insulation of the windings. If insulation which will withstand higher temperatures without losing its insulating qualities is used, higher currents may be passed through the windings and hence the power output may be increased. Therefore, if the allowable temperature rise may be increased the power output of a given motor may be increased or the weight and size for a given output may be reduced.

Insulation Restricts Output

Class *A* insulation, including organic materials such as silk and cotton, allows a temperature rise of 40 degrees Cent. over an ambient temperature of 40 degrees Cent. Class *B* insulation, including inorganic materials such as mica, asbestos and glass, may have a rise of 60 degrees Cent. over an ambient of 40 degrees Cent. If the ambient is lower than 40 degrees the temperature rise may be correspondingly higher. Mica and asbestos are considered heavy and bulky for use in aircraft motors but glass is well suited to this service. It is relatively light and has a high dielectric strength. Glass-insulated wire is now available while glass-fiber paper and glass-fiber tape may be had for cell and field insulation. With this insulation the power of electric motors is increased appreciably. Several continuous-duty motors with class *B* insulation have been designed.

Although little work has been done in the use of permanent magnets in high-power motors, much thought is being given to this possibility in aircraft motors. Several alloys may be permanently magnetized with a high flux density. If such magnets are used in place of the usual steel or iron pole pieces with wound coils, the weight of the coils will be eliminated and the diameter of the motor reduced. A

motor built in this manner would have the constant speed characteristic of a shunt motor, and the speed could not be controlled readily. Also the starting torque would be low as compared to that of the series motor. For many applications, however, a motor with a permanent-magnet field would be entirely suitable.

There are several special service requirements which aircraft motors must meet, the most important being resistance to vibration, ability to withstand a wide range of temperatures and elimination of radio interference. Field coils must be specially protected to prevent vibration from abrading the insulation and causing grounds. All screws must be safety type with tie wires or lock washers while bolts must be held with self-locking nuts. In order to operate satisfactorily in temperatures ranging from 50 degrees Fahr. to 200 degrees Fahr., geared motors must be provided with special lubricants in the gearbox. Most geared motors for aircraft applications are of the intermittent-duty type and hence sufficient lubrication is provided if the gears are coated with a wide-range grease. To prevent interference with vital radio communication, motors must be completely shielded with all metal parts of the housing bonded together and connected to ground.

Lately because of the possible presence of gasoline vapor, explosion-proof motors are frequently specified. Such motors must be totally enclosed, constructed to prevent the entrance of explosive vapor

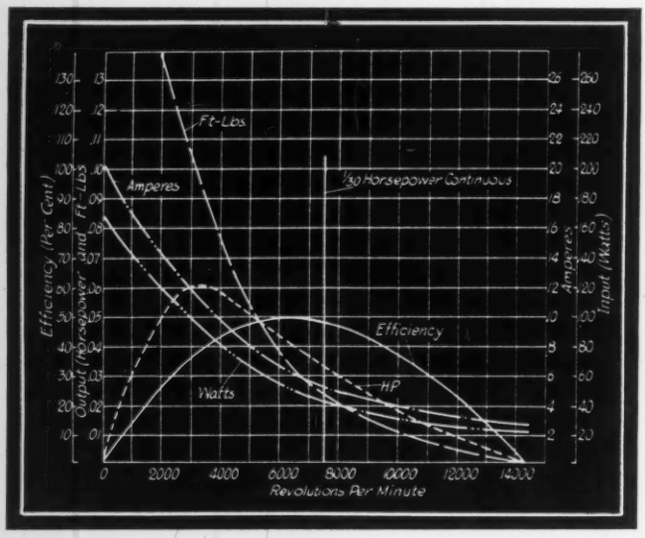


Fig. 6—Characteristic curves for a typical 12-volt motor used for continuous service as for pumps and blowers

and able to withstand an internal explosion without propagating the flame externally. These motors have greater wall thicknesses, longer bearings, sealed lead outlets and brush caps. Hence they are somewhat heavier than ordinary types.

Disadvantages of special lightweight direct-current motors for aircraft service include maintenance expense, relatively high cost, slow delivery and extensive development work. Carbon brushes wear and must be replaced periodically. The commutator wears and must be refinished at intervals. The interior of the motor housing should be cleaned of carbon dust and dirt to prevent short circuits and grounds. Winding insulation deteriorates through age, temperature changes, moisture and vibration. All of these factors, which are not present or are present to a lesser degree in the alternating-current induction motor, must be provided for in the use of the direct-current motor.

Require Special Development

High cost and slow delivery are the result of special requirements and relatively small quantities used. Motors which are especially designed for a particular application to achieve maximum weight reduction generally cannot employ standard parts manufactured in large quantities. The motor manufacturer must often start from the beginning, carrying on detailed experimental and research work, making special castings and machining special parts in small lots. The construction of a precision built high-speed direct-current motor requires a large number of man hours and delivery usually is not as rapid as that of induction motors.

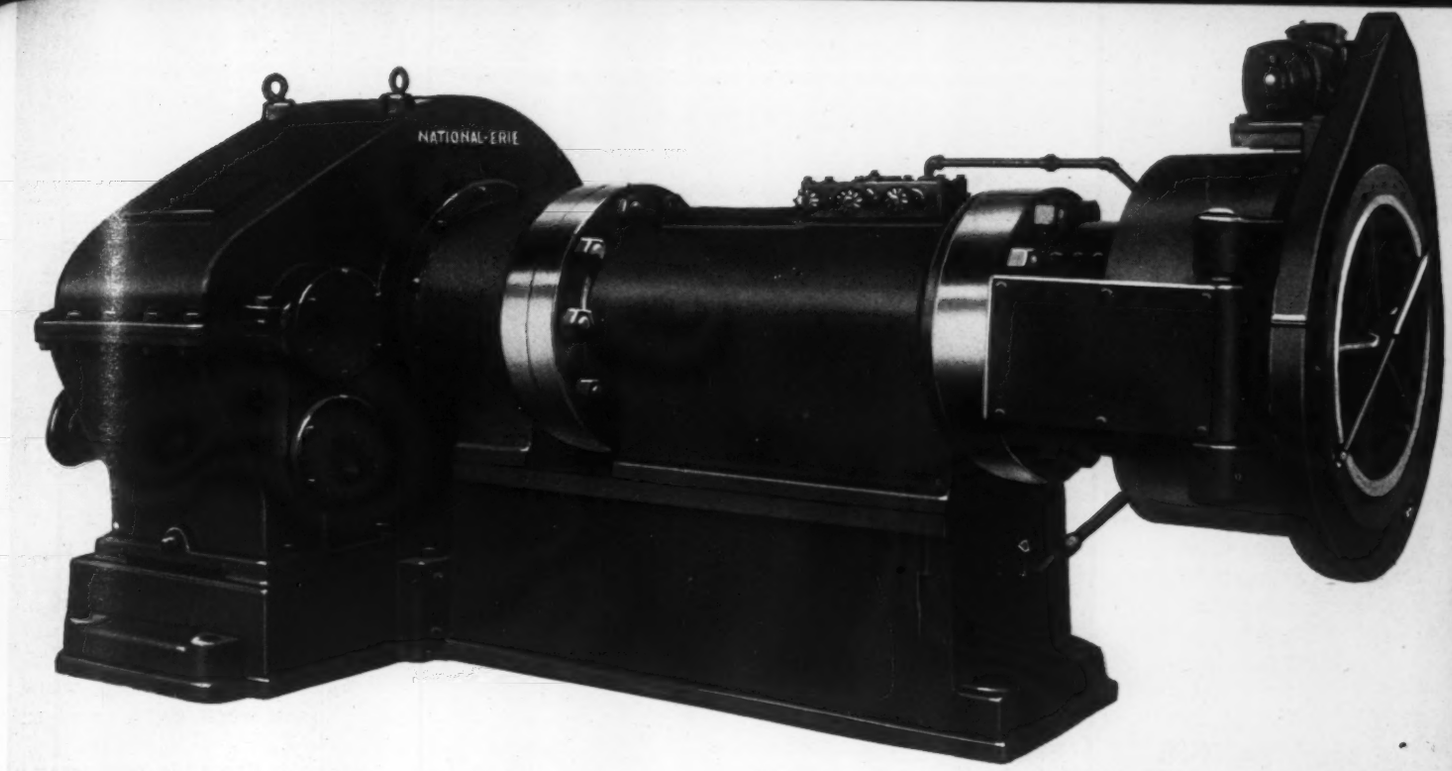
Applications of aircraft motors may be divided into two general classifications: Those requiring high-torque intermittent duty motors and those requiring moderate-torque continuous duty motors. In the first classification are wing flaps as shown in *Figs* 2 and 3, cowl flaps, oil cooler flaps, retractable landing gear, power-driven gun turrets, etc. These devices require a high starting torque and are in operation for one minute or less. The motors may be made as small and light as possible without regard to the heating of the windings. Performance curves for a typical cowl flap motor, as installed in the bomber in *Fig.* 1, are shown in *Fig.* 4. A special feature of this type of motor, necessary because of definite limitations of travel of the driven member, is a magnetic clutch which disengages the motor and prevents the momentum of the armature from jamming the mechanism.

Continuous Operation Reduces Rating

In *Fig.* 5 is shown a motor-powered retractable landing gear on a Beechcraft biplane. A high-speed motor, operating through a worm gear reduction drive, fully extends or retracts the gear in a little less than four seconds. This single retractable gear increases the cruising speed of the plane by more than 20 miles per hour.

In the second classification are such devices as fuel pumps, oil pumps, anti-icer pumps, hydraulic pumps and blowers. On larger airplanes there are also condensate pumps for heating systems and refrigerators. Motors for these applications need not have high starting torque but must operate continuously. They must be either ventilated or, if totally enclosed, large enough to prevent overheating. It is essential of course that fuel pump motors be explosion-proof, and other motors in this classification are frequently made explosion-proof, particularly on military airplanes.

(*Concluded on Page* 100)



Cast Steel Takes the Load!

By J. A. Shuffstall
National-Erie Corp.

LIKE other types of materials, cast steel has inherent properties which fit it for specific applications. But even though cast steel may be desirable in modifying an existing design, almost insuperable obstacles may be encountered either because of the nature of the material or because of foundry restrictions.

In the 12-inch crude rubber extruding machine in *Fig.* 1 toughness and resistance to shock and impact were especially required of working parts, but cast steel could not be specified until the design was changed to overcome the difficulties mentioned.

Driven by a 175-horsepower motor, this machine extrudes approximately 8000 pounds of crude rubber per hour and is said to be the first all-steel unit built. All parts subject to wear and strain are made of special cast steels, heat treated to provide desired physical properties.

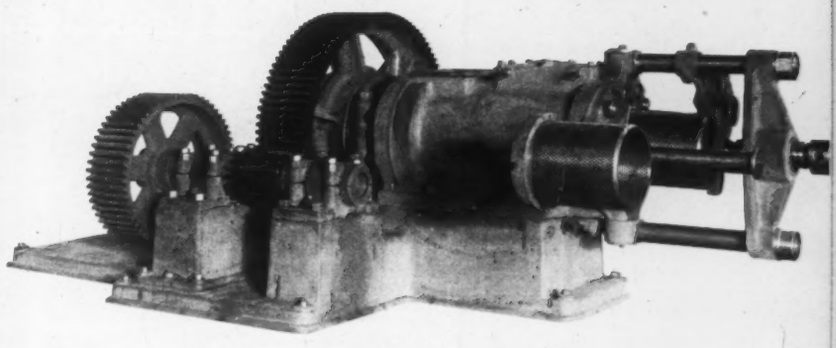


Fig. 1—Top of Page—Crude rubber extruding machine requires toughness and resistance to shock and impact in working parts. Design had to be changed to permit specifying cast steel. Fig. 2—Above—An older model built in 1918 which included many heavily stressed parts of cast iron

Comparison of the machine with that in *Fig.* 2, built in 1918, shows its evolution. As an example of the changes made, the drive and reduction gears in the older model were cast iron.

Actual extrusion takes place through the spider, show in *Fig.* 3, a cross section of the machine. Because

the spider is subjected to severe strain, heat treated alloy steel was chosen which has a tensile strength of 100,000 pounds per square inch and a yield point of 45,000 pounds with 50 per cent reduction of area. Failures have been nonexistent with such physical properties. The clamping ring near the spider has the same properties and is assembled and works in conjunction with the spider. Stainless steel is used for the perforated strainer plate containing a series of drilled holes through which the rubber stock is extruded.

The particular design of the strainer head shown permitted use of cast steel for the first time, although steel would have been employed long before if feasible. Other materials failed frequently but the complicated design precluded cast steel. Usual design called for a water cooling space which had to be cored out, using what is commonly called a "jacket core." In cast iron foundry practice this type of casting is not particularly difficult to manufacture, since iron is not poured at such high temperatures as steel. Hence iron foundries did not encounter much trouble in removing the jacket type cores which were almost entirely enveloped by metal.

Fig. 3—Cross section of extrusion machine. Redesigned parts include spider, strainer head, and main cylinder. Thin sections of the gear cases demanded a foundry technique involving special patterns

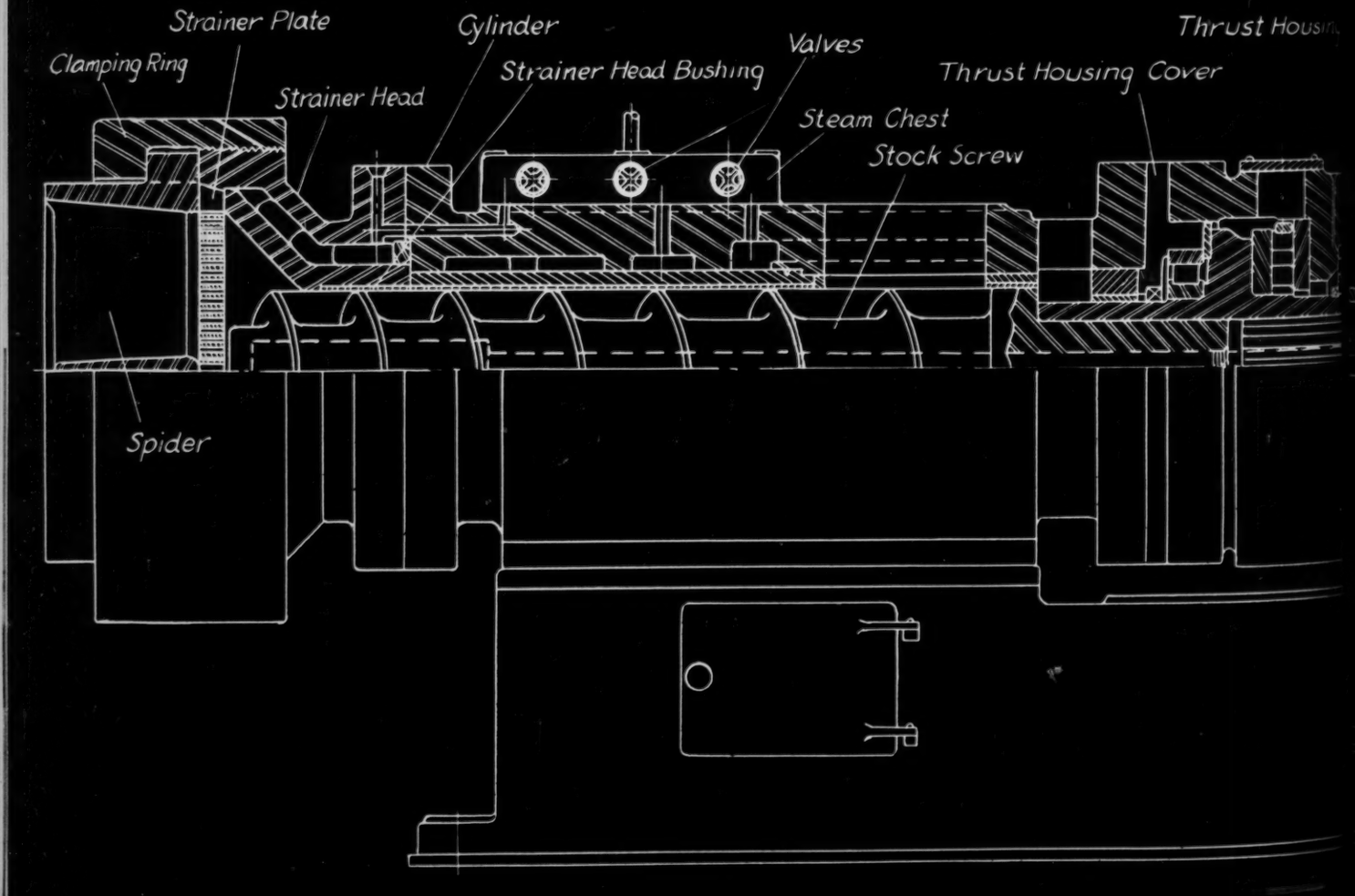
Composite design of present strainer head, including two separate steel castings, is clearly shown in the cross section. Each casting is thoroughly processed and cleaned, particularly on the surfaces forming the cooling space, then rough machined, assembled and electric welded.

Cooling Space Flexible

Two most important objectives of this redesign were (1) economy of manufacture, and (2) freedom to reduce the width and length of the cooling space to any desired dimension. In the case of an integral casting, even though the designer wishes a shallow cooling space, it is impractical from a foundry angle since the core must be of sufficient thickness to allow the proper bonding and anchorage of cores in relation to the thickness of the metal sections surrounding the core. The new design eliminates the difficulties formerly experienced in the foundry, where tremendous production losses were experienced on this part.

The strainer head bushing indicated is heat treated to provide maximum wear resistance at the point of greatest wear. The design makes replacement easy.

For the same reasons as in the case of the strainer head, the main cylinder was redesigned. The old de-



sign required box type construction, forming a cooling space necessitating a jacket core and creating difficult foundry problems. In the cast steel redesign the water cooling space is now formed only after the pressing in and assembly of the cylinder bushing, making a reasonably simple casting.

Special alloy steel forgings are cut to form the stock screw shown. The flights throughout its length are flame hardened to 500 brinell and are hollow bored for water circulation.

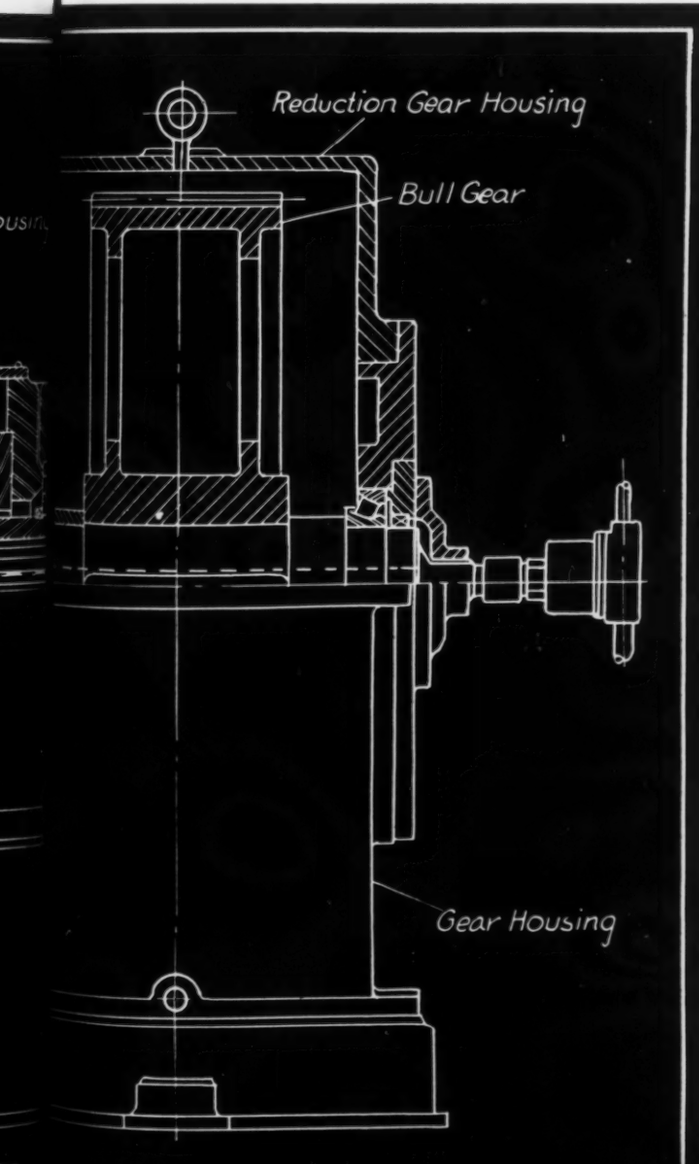
Gear Case in Two Sections

Steel was selected to provide the necessary sturdiness in the thrust housing which is a part of the drive and carries the main gear drive, main drive sleeve, outer radial and main thrust bearing. Independent of the thrust unit is the gearcase, designed in two sections as indicated and containing the cast steel drive and reduction gears and forged steel pinions. Inspection of the bearing is possible through a port. Weight was reduced in the case by specifying steel, and mechanical properties were retained which provide ample strength and rigidity to insure proper alignment of parts. This unit may be easily removed without dismantling the drive gear unit.

Thin section of the cases demanded an interesting special foundry technique involving specially constructed patterns mounted on molding boards for economy. Instead of the interior of these cases being cored in the conventional manner the interior shape of the case is formed by a pattern and is considered part of the mold, allowing it to be made of green sand. This fact eliminates the hazard of cracked castings during solidification of the metal against the usual resistance of baked core sand. The green sand mold can be so constructed that it will collapse readily after the metal has filled the mold, resulting in sound castings without hot tears or shrinkage cracks.

"All-steel" motif of the machine naturally extends also to the gears which have a special analysis responsive to flame hardening. Of the herringbone type, the gears run in oil and are accurately cut to provide a smooth running drive. Flame hardening brings the hardness of the teeth to approximately 400 brinell, leaving the balance of the gear tough and ductile to withstand heavy intermittent loads. The main drive gear is fitted with a special bronze alloy bushing, bored to fit on the thrust housing. Hub is extended for a two-jaw clutch to drive the stock screw.

The machine is a good example of the results obtained through choice of materials and refinements as well as close attention to advantages secured by knowledge of and attention to foundry problems.



They Say . . . .

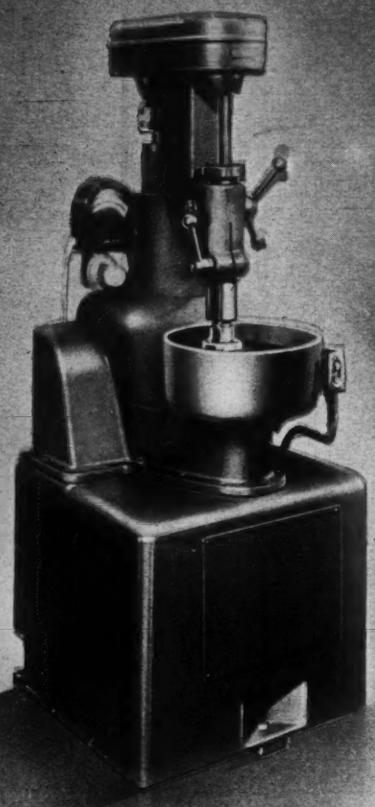
"During 1943, 1944 and 1945 world conditions and the acceleration of the obsolescence of defense materials will require this nation to devote much more of its energy and its substance to defense production than is generally believed. We might very readily delude ourselves if we fall into the error of laying our plans on the premise that when the next peace papers are signed, the national emergency will cease and we shall return to that nebulous state known as normal living."—Charles E. Wilson.

♦

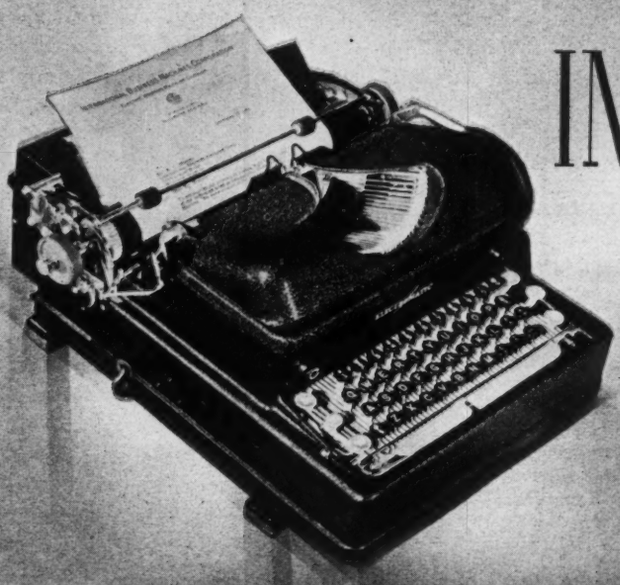
"A survey conducted by the nation's machine tool builders points toward a total machine tool production of $750,000,000 in 1941. This is $300,000,000 above 1940 production and $100,000,000 greater than preliminary estimates for 1941. We are confident the $750,000,000 goal may be reached by increased subcontracting, by working overtime, by maximum utilization of equipment, and by plant expansion where necessary."—Clayton R. Burt.

♦

"The technically trained man has exceptional opportunities. Even though this world is in a turmoil, this is still a great country—the greatest in the world. All this talk about there being no further opportunity in America for brains and initiative is rubbish. Right now American industry in its determined search for its leaders of tomorrow is putting a premium on brains."—Alfred Kauffmann.

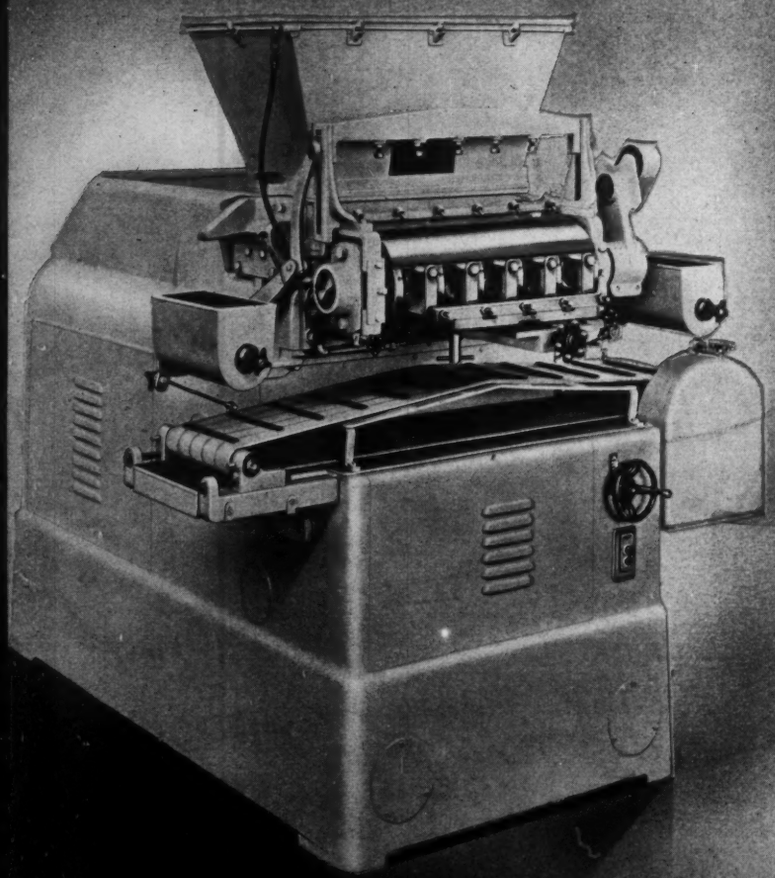


Spindle of the Ultra Lap machine (left) is driven through V-belt and worm gear speed reducer and combines a multiplicity of motions and speeds in the conventional figure eight lapping movements. Smooth corners and absence of crevices insure against dirt gathering on the housing. Controls and adjusting levers are simplified and centralized to minimize required operator skill



Dough passages of American dough divider (below) are lubricated only when machine is operating, by pressure system. Cutting off and scaling movements are actuated by a pair of eccentrics, while other movements are secured by cam action. Contrary to usual practice, all stress members are carried by the heavy, rigid base, side frames being merely enclosures

Proportional escapement mechanism in IBM all-electric typewriter (above) automatically allows space for each character according to its width, varying from two to five units. Along with a single escapement rack are three starwheel escapements one behind the other. Selection of escapements is controlled automatically by selector bars, each one of which has a corresponding type bar

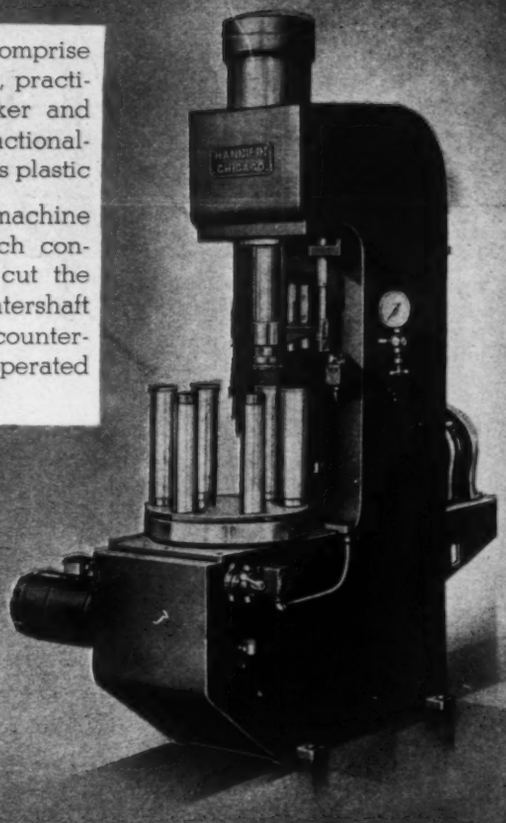


Stiffening ribs in Boice-Crane band saw (right) are concealed and incorporated in welded steel frame so as to form functional portions of the machine. Wheels of machine are designed similar to cross section of high speed turbine wheel and are plastic. Tilting movement is accomplished on double trunnions. V-belt, direct, or gearbox drives are optional. Exposed bearings are grease-sealed

Desi
IN NEW
(For new
THIS MONTH
Chalmers truck-
through coupling
and top shell are
movable. A hydr
located on the
on the head ma

Microphone, recording disk, recorder and transcriber comprise the SoundScriber (left). Disk is wafer-thin metal alloy, practically indestructible. Recorder has built-in loud speaker and volume control switch. Turntable is driven by fractional-horsepower motor, thumb-switch controlled. Housing is plastic

Spindle housings of Hunter worm gear hobbing machine (below) are shaped as cones to actuate a limit switch controlling a two-way electric clutch. Throughout the cut the clutch connects the turret shaft to a low-speed countershaft and for rapid traverse between cuts to a high-speed countershaft. Each of six work-holding spindles has a cam-operated overarm which clamps gear blank during cut



esi atures
EW CHINES

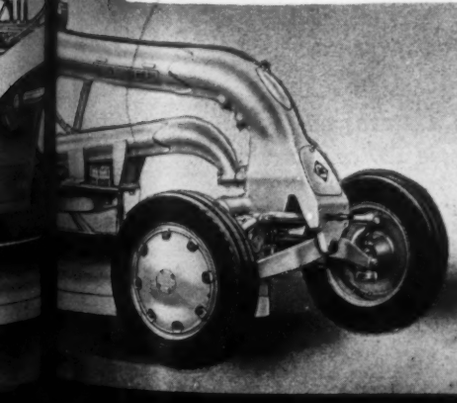
(For new e page 118)

ONTH' Countershaft of Allis- truck-m ory crusher is driven oupling ctor engine shaft. Spider hell are teel casting, readily re- A hydr orting the mainshaft and the cr n plate adjusts for wear ad man ferent types of material

An electrical control actuated by the hydraulic ram on the return stroke operates the indexing table in the Hannifin shell marking press (above). Motor-driven hydraulic power unit is built into rear of the press, making it a self-contained unit requiring only electrical connections. Frame, table support and power unit mounting are welded steel. Indexing mechanism runs in oil

Universal transformer panel is feature of large Tocco Junior heat treating machine (right). Panels to which inductor blocks are fastened rotate to adjust position of blocks from horizontal to perpendicular. Water manifolds and controls are forward, immediately above work pan. All controls and meters are at eye level. Frame is all welded and generators are mounted on three-point suspension

Greater earth-moving capacity is attained in the Allis-Chalmers motor grader (below) by the Hi-Arch front axle which permits dirt to roll off the blade without hanging in the axle or circle and absorbing engine power. Power comes from a two-cycle diesel engine. Ten-inch tubular frame plus heavy box section girders give unusual strength



MACHINE

Editorial

DESIGN

Let's Plan Now To Overcome Shortage of Engineers!

SHORTAGE of engineers, already acute, is likely to become increasingly serious before many months have passed. With all the new government and company plants to be put into operation the number of men required, particularly with engineering background, may well assume alarming proportions.

Gratifying in this respect are the training courses being sponsored both by industry and the colleges at the present time. Of special interest, too, is the suggestion of William A. Hanley, president of the American Society of Mechanical Engineers, that graduation of the engineering classes of 1942 take place at least three months ahead of the customary date—to be accomplished by engineering schools continuing with intensive training through the summer months. Mr. Hanley sees it as a patriotic duty of the universities and students to co-operate in such a program, thus releasing about 14,000 trained men to industry earlier than otherwise would be the case.

One other source of promising engineering personnel seems evident. During the depression years of the thirties many engineering graduates, unable to find satisfactory employment with industrial companies, drifted into other work. Some of these men, if given the offer of brief additional training, might well be induced to return to the engineering field. Engineering societies are registering their members for possible work on the defense program. Could not this registration be extended, either by the societies or the government, to list erstwhile engineers whose services might be used to good advantage?

Forgetting Tradition

THOSE days of "It can't be done" are past. Chief engineers and designers of machines are rising to the current emergency and throwing aside traditions and practices of long standing. Many outstanding designs these days do not necessarily involve refinements tending toward mechanical perfection or unsurpassed length of life—the best design is the one that meets a primary requirement. And as far as the preparedness program is concerned that requirement is speed.

Few better examples of unconventional, single-purpose design could be cited than the shell lathe discussed in the leading article in this issue. Faced with unprecedented conditions in the production capacity of these lathes, in the building of the machines themselves and in the probable shortage of labor for both building and operation, the designer displayed a high degree of ingenuity in developing his machine. That its success is assured, even beyond expectations, has been amply proved on actual production of shells.

Tradition and standard practice play a vital part in normal design and production. Sound judgment based on experience, however, plus a fresh, unfettered viewpoint in meeting emergency conditions, will pay ample dividends in filling the essential requirements of the armament program.

Professional Viewpoints

MACHINE DESIGN welcomes comments from readers on subjects of interest to designers. Payment will be made for letters and comments published

". . . using self-cleaning motors"

To the Editor:

In your "Viewpoints" for February is published a very interesting letter from Mr. Reinhart. He suggests the design of special motors that appear rather complicated from a structural standpoint. If any machines, however, are designed with possibilities for quantity production, suitable motors could be produced.

With respect to the use of sealed ball bearings in self-cleaning motors, this is along the lines of the lint-free textile motor illustrated in *Fig.* 4 in my article in your January issue. In the articles details of construction were not given, but the bearings are of the sealed type with a view toward eliminating oiling and producing a cleaner motor.

—C. W. DRAKE, *Manager, General Mill Eng.*
Westinghouse Elect. & Mfg. Co.

" . . . gives only 31 speeds"

To the Editor:

On page 68 of your January issue the head for one of your patent articles is "Ten Gears Provide 36 Speeds." This should be 31 speeds because there are six possible positions when the driving and driven gears operate directly through a single intermediate, giving identically the same ratio. Therefore, five of these positions being a repetition result only in 31 different speed combinations.

—GRANGER DAVENPORT
Gould & Eberhardt

Mr. Davenport is right and his comments are appreciated.—ED.

". . . to prevent plagiarism"

To the Editor:

Referring to a recent article by Mr. Woodling published in your magazine discussing the protection of design information and drawings submitted to customers, it is common practice for most companies to overlook plagiarism because the offender is usually a good customer or a potential one.

For protection, however, it seems that manufacturers should learn which of their customers are likely to mishandle non-patentable designs and act accordingly. Certainly in today's market, some of us will find it possible to prevent sending quotations in non-patentable directions.

—J. C. FARRELL, *Vice President*
Easton Car & Construction Co.

". . . treating subjects with justice"

To the Editor:

Your policy of publishing material of high quality, even when of supposed limited appeal, is commendable. Also, presenting such material in serial form as in the case of the excellent series on photoelasticity should receive the wholehearted attention of those groups of your readers vitally interested in each particular subject. Only in serial form can involved subjects be treated with justice.

—E. S. AULT
Purdue University

". . . simplifies open-area calculation"

To the Editor:

Because cloth or metal screen is being used increasingly in machines as filters for dust, dirt and foreign objects that may prove harmful to operation, a simplified formula for determining the "open area" might prove useful to some of your readers.

The formula generally used for finding the open area of wire cloth is somewhat cumbersome and gives the closed area. The following formula, however, gives the open area per square inch directly:

$$\text{Open Area} = (1 - ND)\,(1 - nd)$$

where N is the number of wires in the warp per inch; n, the number of wires in the shoot per inch; D, diameter of wires in the warp; and d diameter of wires in the shoot.

For example, the open area of wire cloth having 6 warp wires per inch and 6 shoot wires per inch, the diameter of all wires being .025-inch, is

$$\text{Open Area} = (1 - 6 \times .025)\,(1 - 6 \times .025)$$
$$= .7225 \text{ square inch per square inch}$$

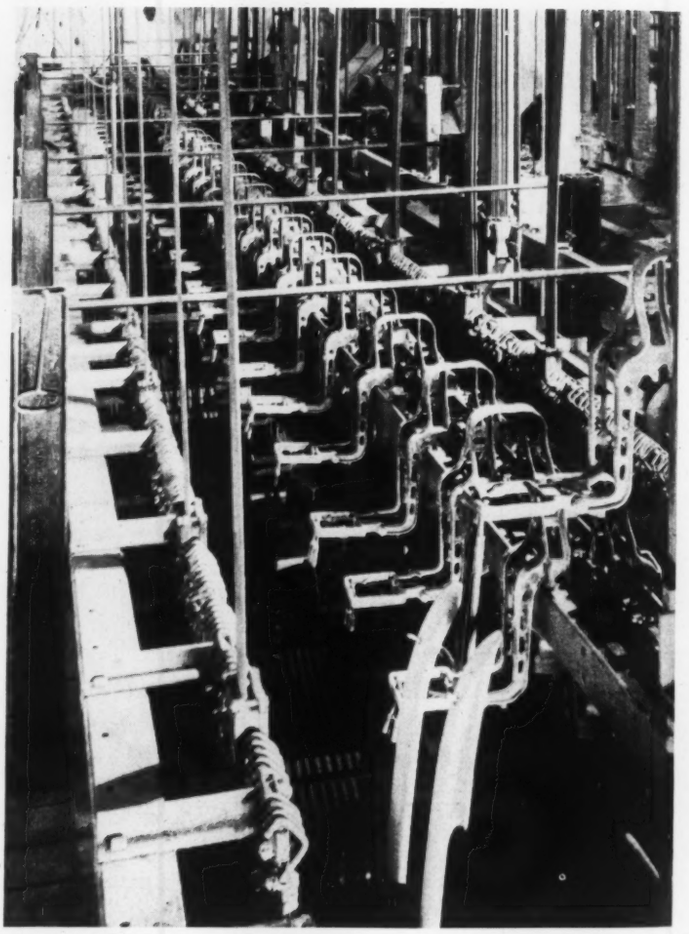
—W. F. SCHAPHORST
Newark, N. J.

Applications
of Engineering Parts and Materials

Rubber Resists Corrosive Attack

PROBLEMS resulting from corrosive attack of reagents in nickel plating baths have been surmounted by a special rubber, Triflex K, developed by the B. F. Goodrich Co. The tank illustrated is in use for plating automobile bumpers. It is eight feet deep, over sixty-seven feet long, almost seven feet wide, and entirely lined with this special rubber.

In addition to being completely impervious to the plating bath solutions the rubber provides the further interesting advantage of not scratching or otherwise marring the highly finished surfaces. Being a nonconductor, insulating difficulties are greatly simplified with consequent eliminated risk of depositing nickel on the tank walls which might otherwise occur if exposed metal vats were used.

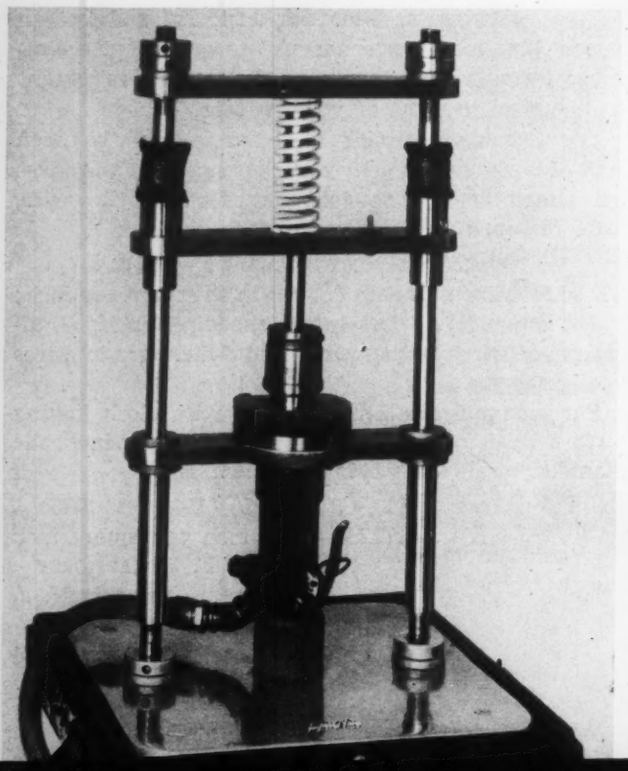


Special lining provides positive protection for nickel plating equipmeni used for finishing automobile bumpers

Vibration Tester Air Operated

ADJUSTABLE over a wide range of frequencies and amplitudes, a pneumatic hammer designed by the Cleveland Pneumatic Tool Co. forms the heart of the vibration testing machine illustrated. Developed by Tinnerman Products, Inc. for use in checking the vibration resistance of its special nuts, tests have been conducted on the machine at frequencies as high as 4000 cycles per minute. Adjustment of the threaded collars at the top of the columns serves to regulate the opposing spring load to effect control of amplitude. A rubber cylindrical block used to back up the hammer, effectively prevents the transmission of vibration to the machine base.

Wide range of amplitudes and frequencies are obtainable with vibration testing machine



Facilitates Airplane Welding

STIMULATED by the defense program, broad extension of welding in airplane construction is exemplified by the application of this fabrication method to the landing gear fork illustrated. Facilitated by the Lincoln Electric Co.'s development of a new

(*Concluded on Page* 104)

Men of Machines

VICE president and general manager for the past two and a half years, Charles B. Jahnke has been appointed president of The Cooper-Bessemer Corp. In addition to his new position he will continue as general manager and member of the executive committee. Mr. Jahnke's service dates back to 1935 when he joined the company as diesel engineer, with an extensive background and training in engineering work with that type of engine. He then became chief engineer, and in July 1937 was made vice president and general manager.

Mr. Jahnke's previous experience includes that of twenty-one years with Fairbanks, Morse & Co., Beloit, Wis., first as chief engineer, then works manager, and finally director of engineering. In 1931 he joined International Harvester Co. and was closely connected with development of the company's diesel engines for farm machinery. He remained here for four years previous to becoming affiliated with Cooper-Bessemer Corp.

CHARLES B. JAHNKE

IN A transfer of approximately forty key production and engineering men from the Buick Motor Division, Flint, Mich., to provide a nucleus for the company's new engine plant staff, Charles A. Chayne, chief engineer, has been placed in charge of engineering activities. Mr. Chayne joined Buick in 1930, and devoted his time to engine design. Later he was named engineer in charge of design and in 1933 became assistant chief engineer. His promotion to chief engineer of the Buick division followed in 1936.

Receiving his mechanical engineering degree from Massachusetts Institute of Technology, he became connected with the National Advisory Commission for Aeronautics at Washington, for a year as junior mechanical engineer. His next position was that of instructor of mechanical engineering at M.I.T., which post he filled for seven years. At the end of this time he left to become resident engineer for Lycoming Mfg. Co., and the Marmon Motor Car Co., in charge of development design. In 1930 he became associated with the Buick division.

CHARLES A. CHAYNE

UPON the recent resignation of its president, Bell Telephone Laboratories announced the appointment of Oliver Ellsworth Buckley as successor. Dr. Buckley joined the Bell System in 1914 immediately from Cornell University where he had been instructor in physics. His first assignments with the company were the study of oscillators and development of vacuum tubes. During the war he was placed in charge of the U. S. Signal Corps research laboratory in Paris, with the rank of major.

After the war Dr. Buckley returned to the laboratories and began an investigation of submarine telegraph cables. With considerable research under his direction in the application of new materials and techniques to these cables, he became identified with the development of a high-speed cable. To achieve this the solution of subsidiary problems concerned not only the making of cable but also the transmission of signals for practical operation. In an engineering test, 1900 letters per minute were being trans-

OLIVER E. BUCKLEY

mitted, an improvement over the 500 letters of corresponding cable then in use.

Dr. Buckley continued his research work, particularly in connection with special alloys for specific applications, and in 1927 was made assistant director of research. In six years he became director of research in which capacity he had charge of fundamental studies in a variety of fields such as electronics, photoelectricity, magnetism, conduction of current, wire and radio transmission, etc. In 1936 Dr. Buckley was elected vice president, in which position he remained until his present appointment.

♦

D. F. SCHMIT, who for the past fifteen years has held various engineering positions in the RCA Mfg. Co. and its predecessor companies, has been named to co-ordinate the activities of the radio, record, cabinet and production engineering divisions. Mr. Schmit's new duties will include co-ordinating and supervising home receiver and television engineering, automobile radio engineering and production drafting.

♦

R. H. HATHAWAY has been appointed assistant to the chief engineer of Hammond Machinery Builders Inc., Kalamazoo, Mich. Mr. Hathaway was previously connected with Production Machinery Co.

♦

DR. VSEVOLOD KRIVOBOK has resigned his professorship in the department of metallurgy, Carnegie Institute of Technology, Pittsburgh, to become director of research at Lockheed Aircraft Corp., Burbank, Calif. Dr. Krivobok has been teaching at "Tech" on a part-time basis since 1931 when he was made associate director of research in charge of stainless steel for Allegheny Steel Corp.

♦

JOHN H. ASHBAUGH, engineering manager at the East Springfield, Mass., plant of Westinghouse Electric & Mfg. Co., has been made assistant manager of manufacturing and engineering for that division, replacing L. E. OSBORNE who has been granted a leave of absence to join the staff of the defense committee, Office of Production Management.

♦

ROBERT L. MANN has recently been appointed chief engineering instructor at Sparton School of Aeronautics to direct the instruction of Aeronautical Engineering and Airline Maintenance Engineering students. Mr. Mann is a graduate of the University of Alabama in engineering, and had been associated with the Douglas company.

♦

HAROLD F. FALK, who has devoted considerable attention to time study and special work in both the shop and engineering departments of The Falk Corp., has been promoted to the position of general superintendent. Mr. Falk is a graduate of the school of engineering of the University of Wisconsin.

♦

ARCH T. COLWELL, vice president in charge of engineering, Thompson Products Inc., Cleveland, has been elected president of the Society of Automotive Engineers, official notification of which was made at the recent annual meeting of the society in Detroit. A complete sketch of Mr. Colwell's engineering experience was published in the November, 1940 issue of MACHINE DESIGN.

♦

N. K. KOEBEL has become a member of the research department of Lindberg Engineering Co., Chicago. He was formerly with Eastman Kodak Co.

♦

MAJOR JOHN H. FRYE has been granted leave of absence to be commissioned in the Ordnance Reserves and placed on active duty in the engineering and development section of the Ordnance Department, Washington. He worked for Columbia Steel & Shafting Co. and the Edgar T. Ward's Sons Co. as metallurgical engineer and metallurgical consultant.

♦

DR. GEORGE ASHLEY CAMPBELL received the Edison medal for 1940, awarded by the American Institute of Electrical Engineers, "in recognition of his distinction as scientist and inventor and for his outstanding original contributions to the theory and application of electric circuits and apparatus."

♦

FRANK W. CALDWELL recently was elected president of the Institute of the Aeronautical Sciences. Mr. Caldwell, who is director of research, United Aircraft Corp., has been a specialist in aircraft propellers since 1916 and received the institute's award in 1935.

♦

ARTHUR H. LEAK, a member of the engineering staff of Wright Aeronautical Corp., is now assistant chief engineer, following the promotion of RAYMOND W. YOUNG to the post of chief engineer.

♦

EDWARD B. NEWILL has been made assistant to E. R. BREECH, vice president of General Motors Corp. From 1930 to 1937 Mr. Newill had been chief engineer of the Frigidaire division, and since that time has been assistant general manager. EDWARD R. GODFREY, who has been head of the Frigidaire manufacturing division since 1930, replaces Mr. Newill.

♦

JAMES L. SHEPHERD has been appointed to fill the position of associate professor of agricultural engineering at the University of Georgia. Until his appointment he was employed on the instructional staff at Abraham Baldwin Agricultural college.

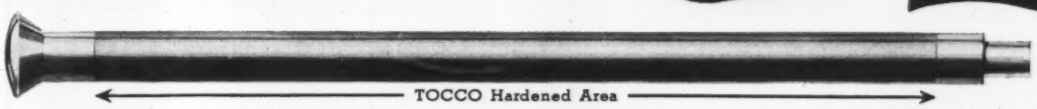
♦

PAUL GILLAN, formerly assistant chief engineer and automotive engineer, Lycoming Mfg. Co., Williamsport, Pa., has joined Aluminum Industries Inc. as a member of its automotive and industrial consultation staff at Cincinnati. He will work with the engineering staffs of automotive, aircraft and industrial companies on parts and casting problems.

♦

L. O. MYHRE, previously manager of engineering and manufacturing for Westinghouse X-Ray Co., has been appointed manager of manufacturing in the radio division of Westinghouse Electric & Mfg. Co., Baltimore.

TOCCO Junior, 3-station unit, with track pin hardening fixtures. Pins, loaded manually, pass down through inductors automatically at a predetermined rate. Pins shown are in final position, hardened to 58 Rockwell "C". Note compact design of the TOCCO Junior. It occupies only 5' x 6'8" of floor space.



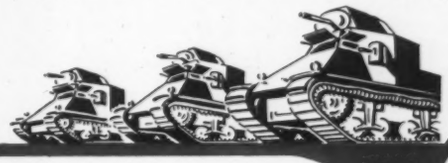
5/8" TRACK PINS SURFACE HARDENED AT 1½" PER SECOND

Another Place Where TOCCO Speeds Defense

● For faster hardening of track pins, a large manufacturer of combat tanks and track type military vehicles, installed a new TOCCO MG 10 Junior. It surface hardens SAE 1045 pins, ⅝" diameter, 12⅜" long at the high rate of 1½" per second. A long carburizing cycle is unnecessary.

Pins emerge from the inductor free of scale and decarburization, hardened uniformly to a depth of 3/32" with the metallurgical structure accurately controlled. Distortion is practically negligible.

You, too, can boost production with TOCCO's Process of Localized Surface Hardening by Electrical Induction. TOCCO Junior machines, furnished with one to three hardening stations, are easy to operate, quick to install, and can also be used for annealing, brazing or soldering. They harden long or short runs and a variety of parts. Units are self-contained with high frequency motor generator sets and pre-set, full automatic controls. Available in several models to suit your needs. Prices are competitive with standard heat treating furnaces. Orders filled promptly.



TOCCO engineers will show you how TOCCO's speed meets your need. Free illustrated booklet on request.

THE OHIO CRANKSHAFT COMPANY
Cleveland • Ohio

TOCCO
"Why Heat Treat the Whole Piece?"

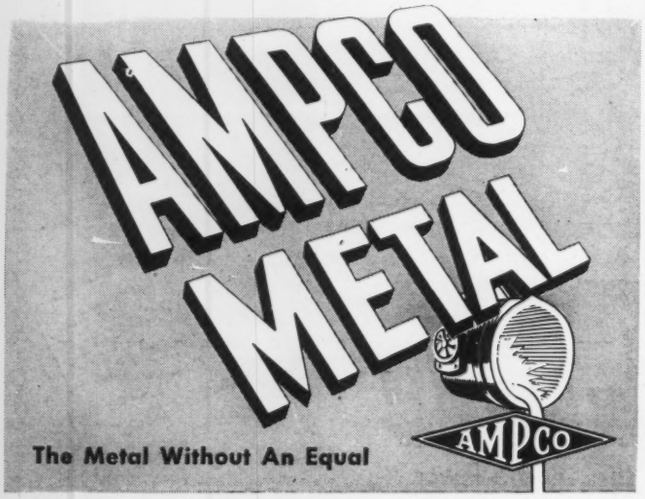
SUCCESS STORY
Outwearing
ALL OTHERS 3 to 1
A manufacturer of bottle caps reports this experience: Guide pin bushings on machines for cutting out bottle caps must not show the slightest variation due to wear. AMPCO METAL, Grade 18, is now used for these bushings, and it's outwearing everything previously used 3 to 1.

. . and that's how ONE Manufacturer Profits by the use of AMPCO METAL

How about you? Is "metal failure" causing trouble in any part of your product or production tools? AMPCO METAL—the service-proved aluminum bronze alloy—may be the answer. It's outstanding in its resistance to wear—its toughness and strength—its resistance to impact, stress, fatigue and corrosion. Where other metals fail, AMPCO very often succeeds. Isn't it worth trying? Explain your problem and our technical staff will work out recommendations. There's no obligation. Write—

AMPCO METAL, INC.

Dept. MD-3 **Milwaukee, Wisconsin**



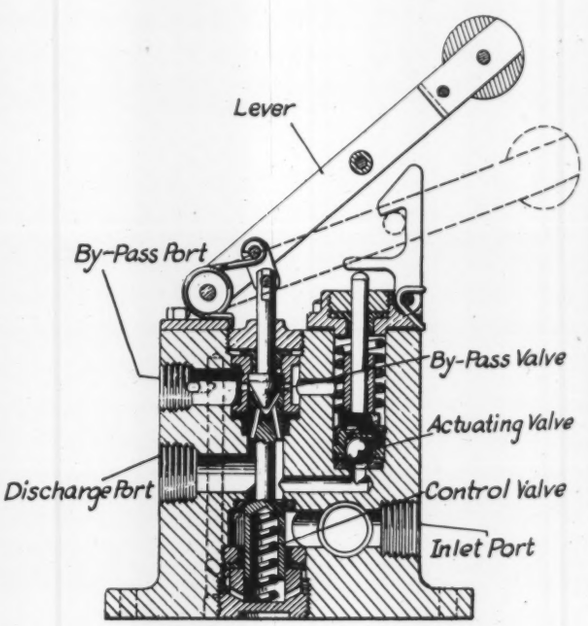
Noteworthy PATENTS

Operates by Discharge Pressure

CAPABLE of controlling the pressure of either liquid or gas, the valve, illustrated, is designed to be installed between a pressure source and hydraulic or pneumatic equipment. The valve, set either mechanically or manually, allows fluid to flow until the discharge pressure reaches a predetermined quantity. At this point the valve automatically trips, isolating the operated equipment and venting or recirculating the pressure fluid. The patent covering this design is assigned to The Acrotorque Co.

When the lever is in the latched position (shown dotted) the bypass valve is thrust downward, closing its floating seat. This seat is also moved downward, opening the control valve against its closing spring. Pressure fluid is thus permitted to flow from the inlet port, through the valve and out the discharge port.

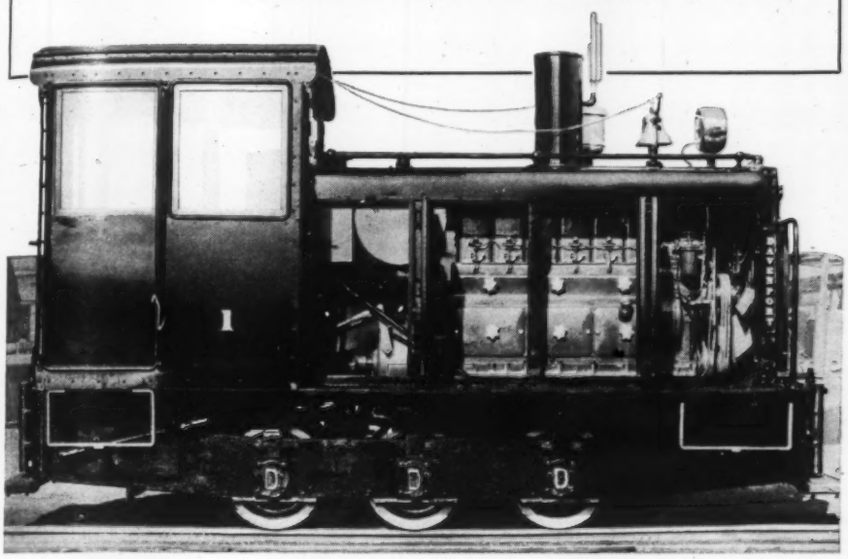
As the discharge pressure builds up, the load on the actuating valve increases. When this load exceeds the spring pressure the valve is raised slightly



Valve is applicable where cyclic control of pressure to a definite cut-off point is desired

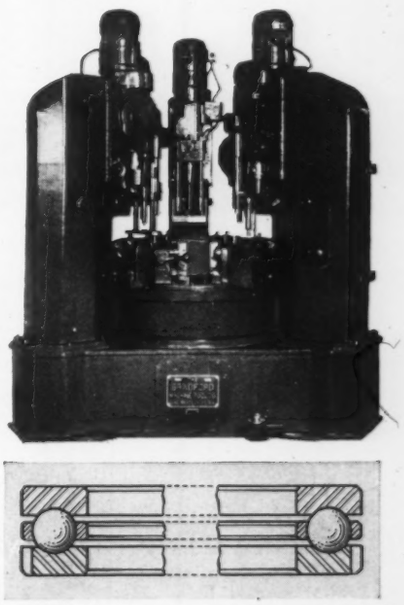
off its seat. Discharge pressure is then exerted against the entire area of the actuating valve piston assembly, forcing it quickly upward. The piston rod unlatches the operating lever which, under the

In the News
WITH BANTAM BEARINGS



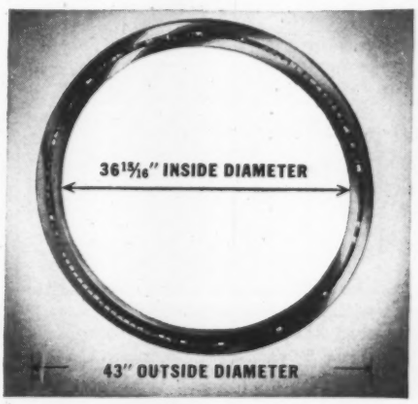
UP-TO-THE-MINUTE LOCOMOTIVE of the industrial type is this unit designed and built by Davenport Besler Corp. for hauling sugar-cane in Puerto Rico. Locomotive replaces steam unit previously used, is powered by 6-cylinder Fairbanks-Morse Diesel engine. Bantam Quill Bearings, used on the wrist pins of the Diesel, are the recognized standard for this service, where their small size and high capacity in oscillating loads are outstanding advantages.

BANTAM'S NEEDLE ROLLERS can be assembled into anti-friction bearings of exceptionally high capacity in proportion to size and cost. Bantam's metallurgical processes provide the hardness necessary for maximum capacity, yet retain needed ductility. Needle Rollers round out Bantam's line of anti-friction bearings—straight roller, tapered roller, self-retained needle, and ball.



6-STATION DRILLING MACHINE built by The Bradford Machine Tool Company turns on Bantam indexing table bearing of the ball thrust type, measuring 30" O.D., 27" I.D., 2" thick. Here is another typical instance of the way Bantam serves industry with custom-built bearings in large sizes or special types. If you have an unusual bearing problem, TURN TO BANTAM.

LOGGING OPERATIONS in rough, hilly country put towing equipment to the severest test. Willamette Hyster Co. improves efficiency, lengthens service life of its HYSTER D2 Towing Winches by using Bantam Quill Bearings on idler gear and reverse idler gear—where space is so limited that no other type of anti-friction bearing could be successfully employed. Moreover, the Quill Bearing is low in cost and easy to install. For further information on this compact, high-capacity bearing, write for Bulletin B-104



THIS GIANT ROLLER BEARING has a radial capacity of 225,000 pounds at 100 RPM, uses 125 rollers 1" long and 1" in diameter. It is one of a group specially engineered by Bantam for use by Ohio Oil Company in central station pumping equipment, to provide high radial capacity and reduce need of servicing.

BANTAM BEARINGS

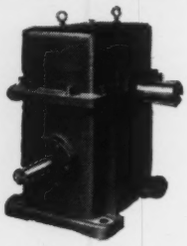
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

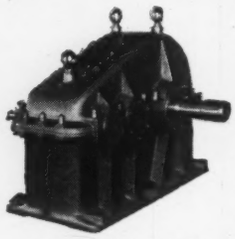
WE ARE READY TO SERVE YOU!

D.O.JAMES

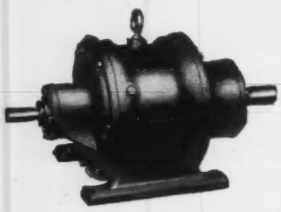
MAKERS OF ALL TYPES OF SPEED REDUCERS AND CUT GEARS



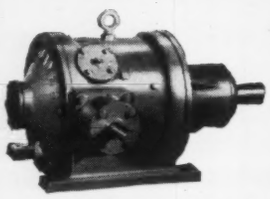
Heavy Duty
Worm Gear Reducer
Horizontal or Vertical Drive
Ratios 6 to 65:1 1/8 to 150 H. P.



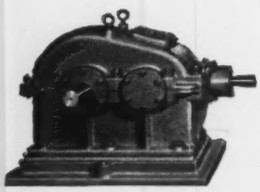
Continuous Tooth
Herringbone Reducer
Single, Double or Triple
Ratios 2 to 350:1 1 to 800 H. P.



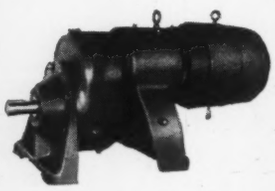
Planetary Gear Reducer
Horizontal or Vertical Drive
Ratios 4 to 1200:1 3/4 to 75 H. P.



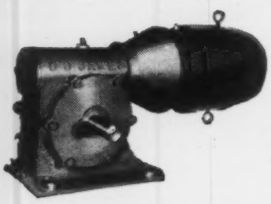
Right Angle Spiral Bevel
Planetary Reducer
Horizontal or Vertical Drive
Ratios 8 to 1200:1 3/4 to 50 H. P.



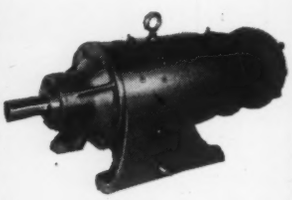
Right Angle Spiral Bevel
Herringbone Reducer
Ratios 6 to 45:1 2 to 250 H. P.



Motorized Speed Reducer
Horizontal or Vertical Drive
Ratios 1.2 to 9:1 3/4 to 50 H. P.



Motorized
Worm Gear Reducer
Horizontal or Vertical Drive
Ratios 6 to 65:1 1/8 to 50 H. P.



Motorized Speed Reducer
Horizontal or Vertical Drive
Ratios 4 to 1200:1 3/4 to 75 H. P.

CATALOGS ARE AVAILABLE COVERING ALL TYPES OF SPEED REDUCERS

D. O. JAMES MANUFACTURING COMPANY
ESTABLISHED 1888
1120 WEST MONROE STREET • CHICAGO, ILLINOIS

FOR OVER 50 YEARS MAKING ALL TYPES OF GEARS AND GEAR REDUCERS

impetus of the spring, assumes the position shown in solid lines. This causes the main control valve to close and, immediately thereafter, the vent or by-pass valve to open.

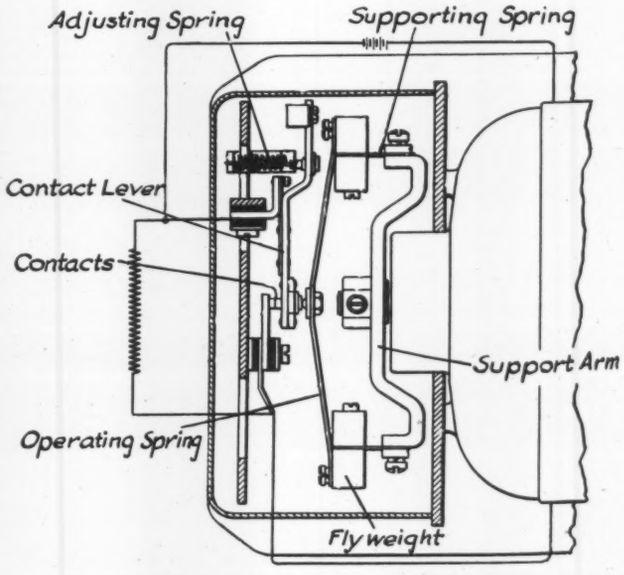
Balanced operation of the control valve head is attained by a packing around its extended portion. Leakage past the packing is then bled through appropriate drillings to the by-pass port. It is evident that providing an adjustment for the actuating valve spring will enable the control to cut off at any desired pressure.

Governor Unaffected by Gravity

DISADVANTAGES accruing from the use of flyweight types of governors have been overcome in a governor design unaffected by gravity. Its features are disclosed in a patent assigned to the Teletype Corp. Developed to control the motor speed of printing telegraph receiving apparatus in airplanes, the governor must hold the speed constant regardless of the position of the plane with respect to the earth.

Built directly onto the motor housing, a supporting arm is fastened to the motor shaft and rotates with it. The two outer ends of this arm each carry a supporting spring in the form of a thin strip. Governor flyweights are attached to the ends of these strips. Connecting the two flyweights is an arched operating spring strip which has at its center a hemispherical thrust bearing.

Hinged to the housing is a contact lever, one end of which exerts a thrust against the operating spring. An adjusting spring and thumbscrew is provided for



Gravity-compensated flyweight governor maintains controlled motor speed regardless of position

regulating this thrust. The end of the lever which bears on the operating spring also carries one of a pair of electric contacts, the other being fastened integrally to the housing although insulated from it.

In operation, as the motor accelerates thus causing

MONEY-SAVING IDEAS

for EQUIPMENT BUILDERS

Nickel Cast Iron News
Published in the Interest of Producers and Users of Cast Iron
Orientals Make Good Use of Alloy Iron Castings
New Abrasion Service Records Made Available
Nickel Steel Topics
Published in the Interest of Producers and Users of Nickel Alloy Steels
Screwdrivers Made to Withstand Rough Treatment
Nickel Steels Play Important Role in Machine Tools
"Bicycle Built for Two"—(Speeds)

Two periodicals mailed FREE on request, cite actual cases

NICKEL STEEL TOPICS—This twelve page illustrated, miniature newspaper is published every second month and is devoted exclusively to Nickel alloy steels. Each issue is packed with illustrated technical and news articles dealing with the production, treatment and uses of these steels in rolled, forged and cast forms. Special features such as a question and answer page and pertinent editorials on technical subjects involving the uses of Nickel alloy steels are included in every issue.

NICKEL CAST IRON NEWS—This publication is a 12 page, illustrated newspaper-type periodical devoted to technical and news articles featuring the production of Nickel cast irons. Editorials and a question and answer section on these materials are special features in each issue. "Nickel Cast Iron News" alternates on a monthly basis with "Nickel Steel Topics".

NICKEL STEELS • CAST IRONS

AVAILABLE ON REQUEST—More Than 75 Publications Covering Various Industrial Fields, Applications and Production Procedures.

Permanently valuable for reference purposes are a large group of publications applying to various industrial applications and production procedures involving the uses of Nickel alloy steels, Nickel cast irons or Nickel containing non-ferrous materials. The titles of these publications with a brief description of their respective contents are set forth in a special catalogue, available on request. For your copy, simply return the coupon below.

The factual, informative material appearing in "Nickel Steel Topics" and "Nickel Cast Iron News" is of considerable practical value as evidenced by the fact that over 100,000 engineers, metallurgists and production men are now regularly reading these publications. You may read them too, at no cost or obligation. Simply mail the coupon at right.

I'D LIKE TO KEEP UP WITH THE NEWS

The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

Gentlemen: Without cost or obligation, please send me the publications checked:

Nickel Steel Topics ☐ Nickel Cast Iron News ☐ List of Current Publications ☐

*Name*_____

MD-3-'41

*Address*_____

*City*_____ *State*_____

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

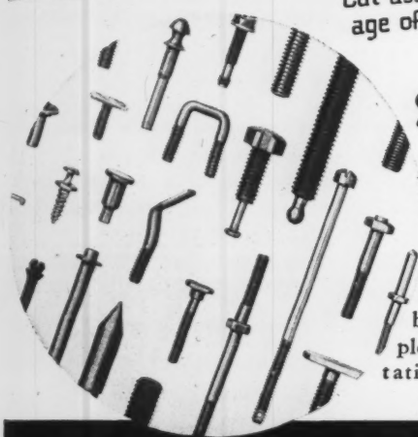
Speed Production
WITH
HOLTITE
SCREWS · BOLTS AND ALLIED FASTENINGS

"LOCK-TITE"
Screws U.S.PAT. NO. 2226491

The lock washer is part of the screw! A new, improved device for metal-to-metal fastenings that embodies in ONE unit all the locking features of washer and screw assemblies plus added economies. *Made to meet specific needs of user.*

HOLTITE-Phillips
Recessed Head, Self-Centering SCREWS & BOLTS

Cut assembly costs an average of 50% and more.



SPECIALS

We have the most complete facilities for producing special parts and fastenings exact to specifications. Send blue prints or samples for prompt quotation.

CONTINENTAL
SCREW COMPANY
New Bedford, Mass. *Warehouses* Detroit & Chattanooga

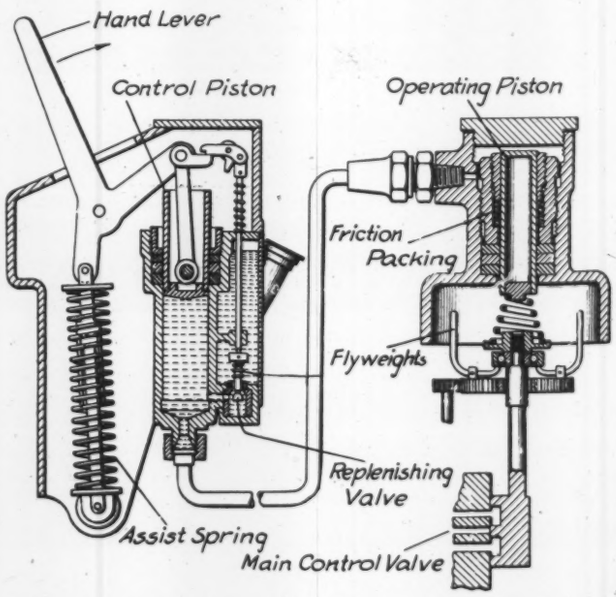
the flyweights to move radially outward, the operating spring arch tends to flatten. The reduced thrust against the contact lever caused by the flattening of the arch enables the adjusting spring to rotate the contact lever about its hinge thus opening the contacts and breaking the motor circuit.

By maintaining the arch of the operating spring unaffected by gravity regardless of the position of the governor, constant speed is obtained. When the motor shaft is horizontal and the supporting arm vertical as illustrated, any tendency of the lower weight to flatten the arch is compensated for by the tendency of the upper weight to increase the arch. When both the motor shaft and the supporting arm are horizontal, the width of the supporting spring strips prevents any vertical displacement of the weights. Similarly, when the motor shaft is vertical there can be no displacement of the weights because the strips are then either in tension or compression.

Expansion Effect Eliminated

HYDRAULIC control circuit, illustrated, is designed to act as the pilot control for a main hydraulic system to position adjustable pitch propeller blades. The manner, however, in which the effect of thermal expansion of the fluid is prevented from affecting the control and also the incorporated means for replenishing leakage fluid should find extensive application in many hydraulic systems. Features of this design are covered in a patent assigned to Sperry Products, Inc.

Movement of the hand lever displaces the control piston and forces hydraulic fluid through an interconnecting line to move the operating piston. This movement actuates the main control valve in the hydraulic power circuit to adjust the propeller pitch. Interposed between the main control valve and the operating piston is a flyweight governor driven by



Complete pilot circuit for hydraulic pump and motor is compensated for temperature change and leakage

Steel Castings provide greater Strength—Stability—Economy

Greater capacity, with the increased strength that means safety at higher running speeds, are the contributions of steel castings to the modern boxcar.

D. S. Ellis, Chief Mechanical Officer of the C. & O., says: "With every improvement safety is given first consideration. The use of Cast Steel truck frames in place of the arch bar type is an outstanding achievement from a safety standpoint."

For improving and modernizing your own product, consider a wider use of steel castings. Often you'll save on the amount of metal required as well as on the cost of fabricating it. For steel castings permit better weight distribution, combinations of parts, reduced maintenance, lower machining and assembly costs, and provide a wide range of desirable mechanical properties.

Your local foundryman will be glad to work with you, with suggestions and recommendations. Or you may consult, without obligation, Steel Founders' Society, 920 Midland Bldg., Cleveland, Ohio.

Today's engineers and designers are using more and more steel castings—better and safer products invariably result—often with substantial savings in cost.

MODERNIZE YOUR PRODUCT WITH

STEEL CASTINGS

COMMUNICATIONS
RADIO CONTROLS
AIRPLANE CONTROLS
STEPPING RELAYS
COUNTING UNITS
REMOTE CONTROLS
CONTACT SWITCHES
INTERLOCKING CONTROLS
LIQUID LEVEL
U.S. GOVERNMENT SPECIFIED CONTROLS
DELAYED ACTION
TIMING CONTROLS
SOLENOIDS

ONE Answer TO 1001 ELECTRICAL CONTROL PROBLEMS

★ Glance at a few of the electrical control applications posted above. Yours may be there.

At any rate, it is our purpose here to interpret briefly how Guardian Electric Engineers can quickly transform any of your electrical control problems into a quick solution.

RELAYS by GUARDIAN

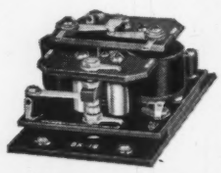
And HOW does Guardian give you a QUICK SOLUTION TO YOUR CONTROL PROBLEM? Consider that thousands of hours have already been spent designing *7146 Standard Guardian Control Parts. Consider that Guardian Engineers encounter thousands of control problems . . . and in 99 out of 100 times . . . Guardian scores a "bull's eye"!

*Inventory Count Jan. 1, 1941

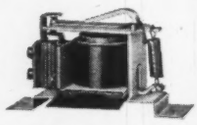
A production sample finished in sparkling chrome or the conventional dress of strict utility . . . is yours for the asking at Guardian.

SPEED — the goal of every production manager, excells any service you've ever heard of . . . at Guardian.

QUALITY — none can surpass Guardian Quality Controls with the best of materials and scientific workmanship guaranteed. Send in your blue print, sketch or specifications. Free Engineering Advice gladly given without cost or obligation.



Series BK—16 Relay. Built to minimum tolerances and the most exacting requirements in production quantities for the U. S. Signal Corps.



Series 120 AC Relay. This relay which sells for less than $1 has operated over 85,000,000 times in an electric fence control, and still remains in excellent condition.

And These Are Not the Extremes in the Guardian Relay Line!

Intitial Your Letterhead for New 1941 Catalog "D" Today. Write

GUARDIAN ELECTRIC
1621 West Walnut Street
Chicago, Illinois

the engine. Thus if a pitch change results in an increase in engine speed, the flyweights, acting as levers, lift the slide valve and increase the pitch. In this manner engine speed and propeller pitch are maintained at a point of maximum efficiency.

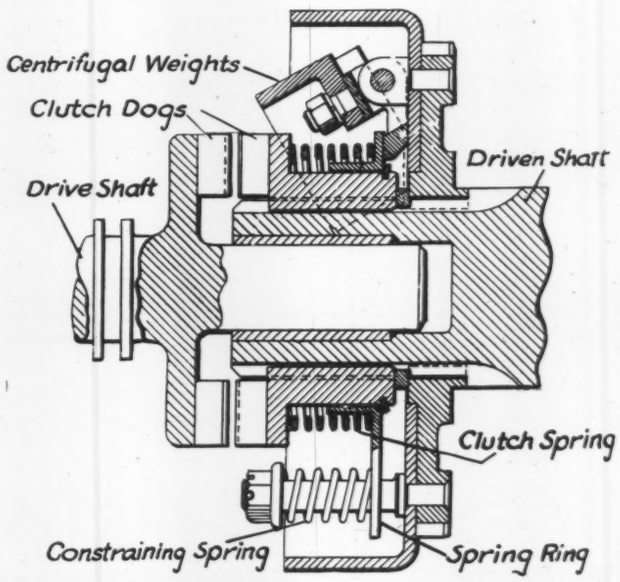
If the temperature of the fluid in the hydraulic control circuit were to change resulting in a change in volume this balance would be upset. To prevent this, a friction packing is installed around the operating piston so that it is more difficult to move than the control piston. Then should the fluid expand with an increase in temperature, only the control piston is moved which does not disturb the main control valve.

In the event of fluid leakage past the packings, provision is made for its replacement from a self-contained reservoir. At each cycle of operation of the control piston, during its upward stroke, the replenishing valve is tripped open. If there is a deficiency of fluid in the system, more is drawn in through the open valve.

Clutch Is Centrifugally Controlled

CONSISTING of a positive jaw clutch of the overrunning type with built-in centrifugal controls, the illustrated mechanism will protect a prime mover from overload and assure engagement of clutch at synchronous speeds only. The patent embodying this invention is assigned to New Products Corp.

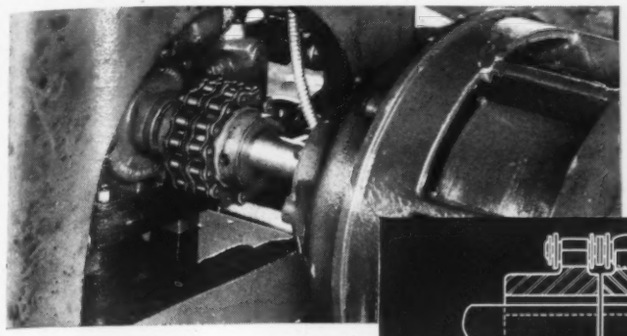
Mounted on pins within a drum splined to the driven shaft is a pair of centrifugal weights. Integral with



Positive type overrunning clutch prevents overload and insures engagement only at synchronous speeds

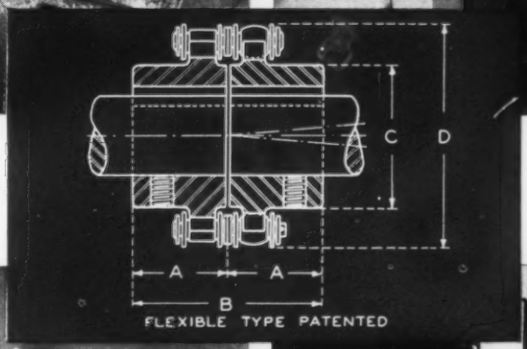
these weights is a lever which bears on the surface of the spring ring. During normal running, the weights are somewhat extended thus maintaining the clutch spring in a partially compressed condition. The dog clutch faces are thus held in engagement. If the driven shaft slows down below a predetermined

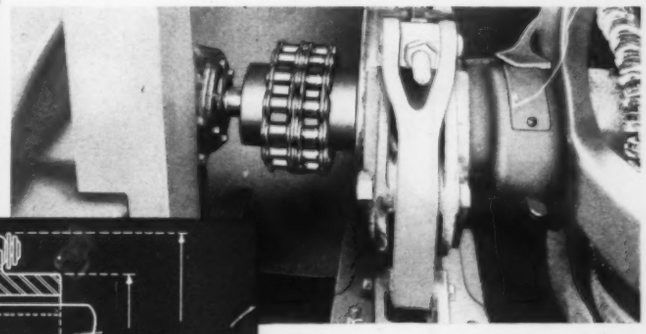
Pertinent Facts of Interest to "Coupling-Curious" Designers!



To a busy *plastic injection moulding machine, this Baldwin chain belt coupling gave desirable quiet, smooth power transmission.*

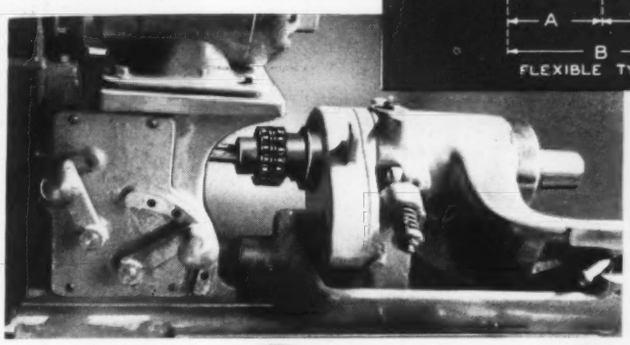
Piston grinding *calls for dependable accommodation of misalignment. That's why this Baldwin flexible chain belt coupling is used.*

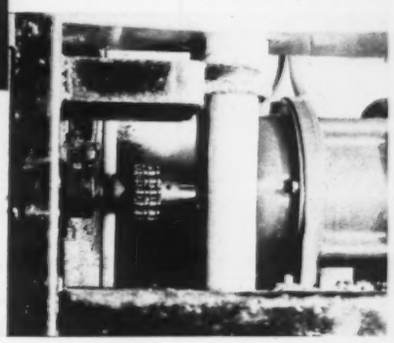




Here a 50 h.p. *Baldwin roller chain belt coupling transmits power from motor to drive shaft on a modern rubber calender.*

Quiet reigns *on this ice machine drive since a noisy, "just as good" coupling was replaced by a Baldwin roller chain belt coupling.*





Designed for "Giving"!

(AND WITHOUT DESTRUCTIVE BACKLASH)

Here's a flexible coupling that's *truly* flexible, yet completely free of backlash! Here's flexibility obtained without sloppy fits—without clearance between component parts (which are the sources of the freedom of action in conventional roller chain couplings).

How come? Briefly, Baldwin flexible couplings are unique in design, consisting of two sprockets coupled by a *special* roller chain belt. One strand of chain belt has cylindrical rollers which fit the sprockets snugly. The second strand has *oversize convex rollers* which allow freedom of movement, a spring-like action that gives Baldwin couplings actual "*torsional flexibility*"! They operate efficiently under misalignment up to 6°!

And another thing: they cost no more than any other *good* coupling; yet they give you so much more in service that the sensible thing to do is to investigate them without delay. Call the Baldwin man or send for the catalog at right.

ARE YOU... "COUPLING-CURIOUS"?

HERE ARE THE ANSWERS!

Pages 60 to 68 in the Baldwin Catalog M tell the whole story—of how many sizes and types of Baldwin couplings are available from stock; dimensions, cover information, capacities, etc. Call the Baldwin man and ask for your copy or write today! See the address below.

Please address inquiries to:

BALDWIN-DUCKWORTH

Division of Chain Belt Company

320 Plainfield Street, Springfield, Mass.

Factories at Springfield and Worcester, Mass.

No one trips over a mountain

It isn't always the big problems, in building a major unit, that slow up production . . . it's the minor parts that consume man-hours and machine-hours . . . cause delays and interrupt the work cycle.

That's why nationally-known manufacturers depend on the Twin Disc Clutch Company for their clutches. They recognize the value of Twin Disc's 23 years of specialized clutch experience. They know it pays to buy from a dependable source of supply. They realize that the name *Twin Disc* stands for proved clutch performance, long life, simple, one-point adjustment . . . that a Twin Disc Clutch adds to the salability of an engine . . . a machine tool . . . a drilling rig or a power shovel.

If you build your own clutches, why not compare your clutch performance and its cost with standard units built by the Twin Disc Clutch Company? Blueprints and engineering data on request.

1. Twin Disc Machine Tool Clutch used by 90 per cent of the members of the Machine Tool Builders Association.
2. Twin Disc Power Take-off standard on most industrial power units.
3. Twin Disc Hydraulic Torque Converter for logging machinery, cranes, and oil well drilling equipment.
4. Twin Disc Heavy-duty Clutch for power shovels, drilling rigs, and road machinery.
5. Twin Disc Marine Reverse and Reduction Gear for all types of boats using 25 hp. to 215 hp.

TWIN DISC CLUTCH CO. • 1325 RACINE ST. • RACINE, WIS.

speed, the weights are retracted which reduces the clutch spring thrust and induces the clutch faces to disengage. The constraining springs serve to insure that the spring ring follows the weight lever.

In engaging the clutch, the inclined surface of the teeth of the overrunning type dogs gradually brings the driven shaft up to speed. Since the spring system is adjusted for a certain prime mover speed, the flyweights overcome the spring load and engage the clutch when this speed is attained. Thus engagement is possible only, with automatic control, at substantially synchronous speed.

Manual operation of the clutch, if desired, is provided by a clutch fork collar formed on the drive shaft. Manual operation automatically cuts out the centrifugal control.

Lathe Design Unfettered by "Standard Practice"

(*Concluded from Page* 32)

unclamps the cylinder and causes it to be withdrawn.

Depending upon the operation being performed, collet type chucks or internal expanding arbors are used on the spindle end to clamp the shell. These are also operated hydraulically.

Actually six of these lathes are used to produce shells, each performing a single set of operations. The particular unit detailed in the foregoing is a composite of the design features of all six machines.

With the exception of the method of chucking, the spindle ends are identical. However, for certain of the operations on the nose and tail of the shell the machines are made without tailstock assemblies.

Since the six machines are to be set up in a battery a single central hydraulic system is planned which will supply pressure fluid to the entire line. In this way increased economy in installation is attained.

Incorporates Centralized Lubrication System

Also anticipated is the use of a central coolant system pump and filter which will draw fluid from a sump in each machine, filter it and return it to the line supplying the battery. Avoidance of overheated coolant will result from such a system as well as reduced cost per installation.

Each machine has its own centralized lubrication system, the lubricant being circulated from a sump through filters by means of a pump. A pressure switch in the pump discharge line prevents operation of the machine unless there is a full flow of lubricant.

Several pilot machines were built according to this design and have been thoroughly tested. Operating specifications pertaining to machining time and rate of shell production have been materially bettered and the lathes are now being produced in quantity effectively eliminating another defense bottleneck.

Prefabricated Machine Housings

Revolutionary New Patented Principle Provides

- LOW COST
- HIGH STRENGTH-WEIGHT RATIO
- EASY ASSEMBLY AND DISASSEMBLY
- NO RIVETS—NO WELDS

Here is an entirely new type of light steel housing — known as Lindsay Structure — that speeds up production and cuts fabrication costs.

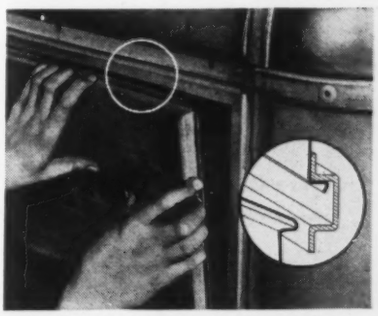
In Lindsay Structure, panel sheets are held in high, uniform tension between framing members by a special patented principle. These "pre-tensed" panels greatly reinforce the framing and bind it rigidly together into an integral unit. Hence, there is no need for crossbraces, gussets, and struts.

Lindsay Structure housings are fastened together without riveting or welding. Structures can be assembled and disassembled any number of times, as easily as the simplest bolted construction. By unloosening a few screws, single panels can be removed for access to enclosed machinery.

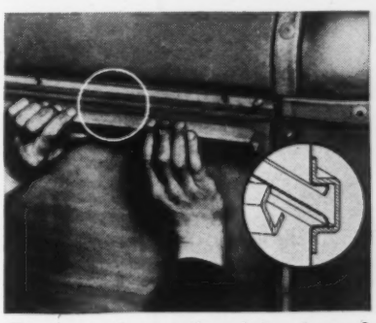
Mass production of parts in 4500 standard sizes makes Lindsay Structure inexpensive. Yet, housings can be "tailored" to the exact shape of your product, within one-half inch of any desired size.

Lindsay Structure's smooth exterior has the appearance of a machine-finished job. Housings are available in plain and galvannealed finish, or enamel finish with chrome trim. Ideally suited for air conditioning housings, dryers, furnace housings, coolers, shipping containers, truck bodies, marine and railroad uses, etc. Investigate this new structure for *your* product.

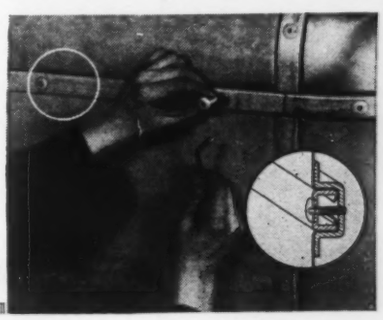
HOW Ls IS ASSEMBLED

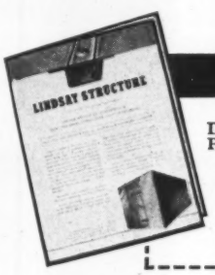


Die-drawn edges of side panel being fitted into channel of framing.



Tensioner being placed in channel over "lipped" edges of panel sheet.





SEND FOR NEW BOOKLET

Dry-Zero Corp., Lindsay Structure Div., 222 North Bank Drive, Chicago, Ill.
Please send me further information on Lindsay Structure.

NAME ..... TITLE .....
ADDRESS .....
CITY ..... STATE .....

LINDSAY STRUCTURE

U. S. PATENT 2017629
U. S. and Foreign Patents Pending

Parts for Lindsay Structure Are Die Rolled, Die Drawn, and Die Cut

A change to PLASTICS

Gives Complete Transparency
Eliminates Assembly Operations

The advantages of plastics over any other material or combination of materials in this safety guard are typical of the benefits derived from G-E Textolite in numerous industrial products today.

Of prime importance in this application is the transparency of the material which gives the operator a clear view of the entire process without opening the guard. Equally desirable is the elimination of any assembly operation in the manufacture of the part—an obviously economical feature.

In many cases, a single molded part performs the same functions as several parts of other materials. This not only eliminates assembly operations, but does away with various machining operations that increase cost.

For a copy of new "1 Plastics Avenue" booklet, write Section C-35, Plastics Department, General Electric Co., 1 Plastics Avenue, Pittsfield, Mass.

PD-154

PLASTICS DEPARTMENT
GENERAL ELECTRIC

ASSETS to a BOOKCASE

Practical Solution of Torsional Vibration Problems

By W. Ker Wilson; Volume I, second edition, published by John Wiley & Sons Inc., New York; 731 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN *for* $8 *postpaid.*

Since the first edition of this book was published in 1935 there has been, as stated by the author, "an increasing tendency toward regarding vibration study as a necessary accompaniment of sound fundamental design." Considerable progress has been made in accumulating data relating to fatigue phenomena with particular reference to the influence of structural discontinuities in causing zones of high stress concentration.

The author has found more general application of the principle of tuning oscillating systems so that severe critical zones do not occur in the operating speed ranges. Where a completely satisfactory solution cannot be reached by tuning methods alone, a general tendency has appeared of employing vibration absorbers instead of energy-destroying dampers. An outstanding example of this trend is the development of the rotating pendulum absorber in radial aircraft engines.

In the light of these facts, the book has been largely rewritten and several chapters have been added. Flexible couplings are treated more comprehensively, with special reference to rubber in shear couplings. Considerable additions have been made to the subject matter relating to geared systems, including geared engines supported on flexible mountings. A full discussion of instrument theory and calibration is included with the material on vibration measuring instruments. Designers concerned with transmission problems will particularly like the treatment of properties of materials used in transmission systems, including a study of fatigue phenomena.

□ □ □

Analytical Mechanics for Engineers

By Fred B. Seely and Newton E. Ensign; third edition, published by John Wiley & Sons Inc., New York; 450 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN *for* $3.75 *postpaid.*

Divided into four parts—Statistics, Kinematics, Kinetics and Special Topics—this textbook like its earlier editions attempts to drive home the principles of mechanics by emphasizing as much as possible the student's common experience and by applying the principles to concrete problems of practical value. At the same time the physical rather than the mathematical interpretation of principles is stressed.

Addition of a new chapter on mechanical vibrations in the section on special topics is probably the new edition's high spot. Following the trends of recent design interest, the authors point out that "the prevention of vibration in machine parts and structural members is important in eliminating excessive

emistry answers the Draftsman's Challenge . . .

This new synthetic solid gives you a permanent tracing paper

NERAL OIL. Most tracing papers treated with some kind of oil. neral oil is physically unstable—it ds to "drift" and never dries com- tely. Papers treated with mineral l pick up dust, lose transparency with ge.

VEGETABLE OIL. Vegetable oil is chemically unstable—it oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent, Albanene is unaffected by harsh climates—will not oxidize, turn yellow, become brittle or lose transparency.

Here at last is a tracing paper that will stand the test of time. Albanene is made of 100% pure white rags treated with *Albanite*, a new crystal-clear synthetic solid, discovered through years of research in the K & E laboratories. It is free from Oil and Wax—chemically and physically stable. Albanene will not oxidize, turn yellow, become brittle or lose transparency with age.

You will like the working qualities of this excellent new paper. Albanene has a fine hard "tooth" that takes ink or pencil fluently and erases with ease. It is absolutely dry, does not pick up dust, helps you keep your drawings unusually clean. Because Albanene is permanent, *it will retain all of these qualities throughout the years to come.*

Try Albanene for yourself under actual working conditions. Ask your K & E dealer, or write for an illustrated brochure and a generous working sample.

EST. 1867

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J.

Chicago • St. Louis • San Francisco • Los Angeles • Detroit • Montreal

K&E *Albanene*

REG. U. S. PAT. OFF.

THE STABILIZED TRACING PAPER

Shoes for the "big ones"

The National Rubber Machinery Company, leaders in the manufacture of special rubber machinery, recently developed this huge unit to vulcanize tires for large trucks, tractors and earth moving equipment. Measuring 75 inches between the power arms, it accommodates such tire sizes as 1350-24 and 1600-20, and operates under a total pressure load of 800,000 pounds. Great stresses are transmitted through the gears in both opening and closing cycles.

Ohio Gears were the natural selection for this unit as "National" engineers know Ohio Gears. Experience with Ohio Gear performance in other of their equipment had shown them the fidelity to specifications, and thorough dependability and the long life they could expect from Ohic Gears.

You, too, will find Ohio Gears the effective, economical answer to your power transmission problems. Get in touch with the nearest representative today.

THE OHIO GEAR CO.

1338 E. 179th Street • Cleveland, Ohio

Representatives

*NEW YORK CITY, N. Y.
Patron Transmission Co.
154-156 Grand Street

NEW ENGLAND George G. Pragst
260 Esten Ave., Pawtucket, R. I.

*LOS ANGELES, CALIF.
J. W. Minder Chain & Gear Co.
927 Santa Fe Avenue

GRAND RAPIDS, MICH.
W. H. Slaughter
419 Oakdale St., S. E.

*PITTSBURGH, PA.
Standard Machinists Supply Co.
South 2nd and McKean Street

DETROIT, MICH.
George P. Coulter
322 Curtiss Building

*MINNEAPOLIS, MINN.
Industrial Supply Co.
537 S. Seventh St.

BUFFALO, N. Y.
F. E. Allen, 2665 Main St.

*KANSAS CITY, MO.
Kansas City Rubber & Belting Co.
712 Delaware Street

*SAN FRANCISCO, CALIF.
Adam-Hill Co.
244-246 Ninth St.

LOUISVILLE, KY.
Alfred Halliday, 330 Starks Bldg.

*INDIANAPOLIS, IND.
A. R. Young
518 North Delaware Street

ST. LOUIS, MO.
St. Louis Tool Co.
2319 N. Ninth Street

Stocks carried.

OHIO GEARS

wear, in reducing repeated stresses that are likely to cause the failure of a member by a progressive fracture and in reducing objectionable noise."

Many detailed changes have also been made in the third edition, which has been completely reset. These changes are based on teaching experiences and emphasize points hard to grasp.

□ □ □

Metallurgy of Deep Drawing and Pressing

By J. Dudley Devons; published by John Wiley & Sons Inc., New York; 699 pages, 6 by 9¾ inches, clothbound; available through MACHINE DESIGN *for* $10 *postpaid.*

Problems involved in deep drawing are both mechanical and metallurgical, and the subject is broad. Although a great deal of progress has been made in the art, few attempts have been made to reduce the phenomena and experiences of deep drawing to basic principles. Theory has been compelled to follow practice and development of deep drawn parts has depended on empirical observations.

Yet it is conceded that progress would be more rapid and certain if methods could be based more consciously on definite principles. The designer, who may assume erroneously that any shape he can devise in sheet metal can be produced, has a great interest in any steps taken to clarify the situation.

Purpose of this volume is "to offer in convenient form some portion of metallurgical knowledge bearing directly upon the craft of deep drawing and pressing." It is notable because of the logical way it covers the subject. Defects in various metals and the difficulties encountered in deep drawing them are covered fully and there is a chapter on properties which determine the behavior of metal during deep drawing. As a challenge to the metallurgist, the author lists a number of desired improvements in metal.

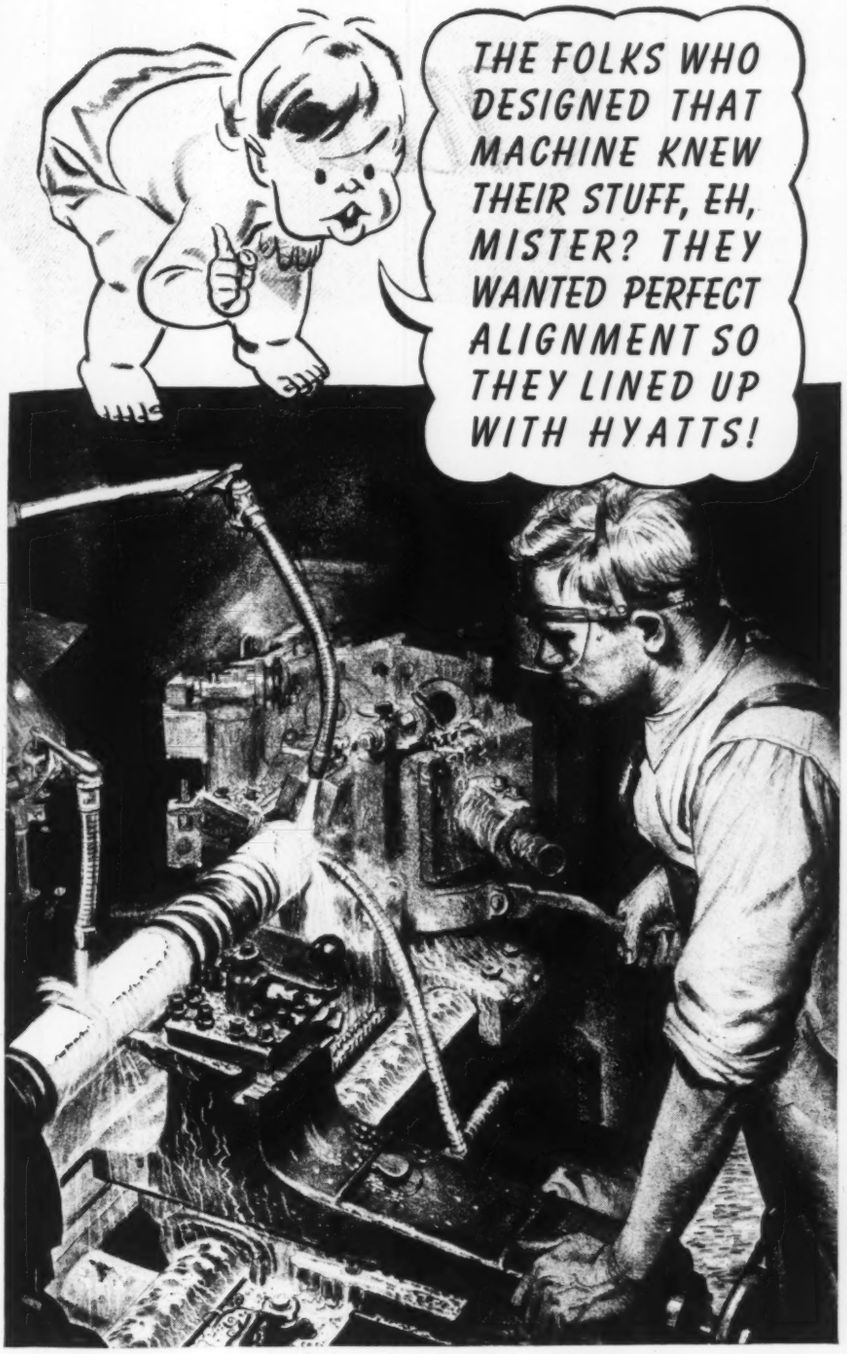
□ □ □

World Directory of Electric Current Characteristics

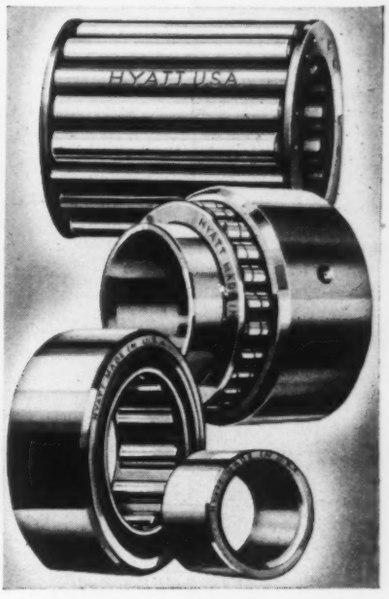
Compiled by and published for E. S. Moore, 1806 Pine street, St. Louis; 62 pages, 8½ by 11 inches, paperbound; available through MACHINE DESIGN *for* $5 *postpaid.*

Data covering electric current requirements in principal cities in 129 different countries and islands is included in this directory, accumulated by the author over 20 years' activity in export sales of electric motors and generators for Century Electric Co. Much of the information was collected personally and the book is claimed to be the first to present the data in such form. Designers whose machines may be sold (during or after the war) abroad will find the information helpful in specifying built-in electric equipment.

Frequency, the voltages for single, two or three phase, and for direct current if any, are indicated for each city listed. In many cases the kilowatt capacity of the plant or plants supplying current is given. Countries and cities are listed alphabetically.


THE FOLKS WHO DESIGNED THAT MACHINE KNEW THEIR STUFF, EH, MISTER? THEY WANTED PERFECT ALIGNMENT SO THEY LINED UP WITH HYATTS!

A bearing for every application! Shown below: Hyatt Junior Solid Roller type, Hyatt Wound Roller type, and Hyatt Hy-Load type.



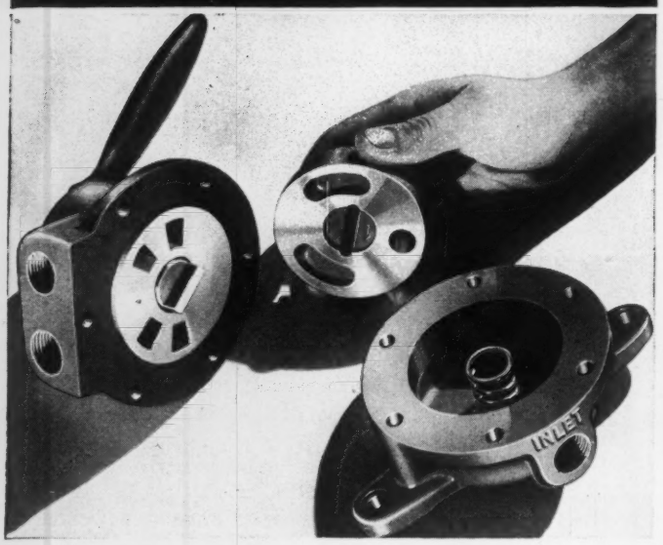
KEEP THEM YOUNG WITH HYATTS whether they be machine tools, cranes, hoists, trucks, or any other mechanical equipment you build or buy. Remember, always, that the best way to keep bearing wear and care *out* is to put Hyatts *in!* Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit and San Francisco.

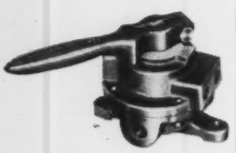
HYATT

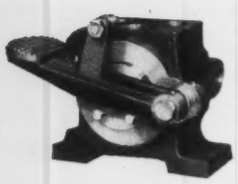
ROLLER BEARINGS

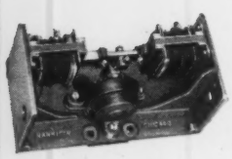
QUIET

Get the MOST out of Air Power









Positive, accurate control of air operated equipment means more production and greatest use of air power. Hannifin Air Control Valves, with their exclusive "Pack-Less" design, prevent leakage and waste of air, assure positive control and smooth easy handling. These valves have no packing, and no leakage or packing maintenance troubles. The bronze disc is ground and lapped to form a perfect seal with the seat, which is similarly finished.

Made in 3-way and 4-way types, hand and foot operated, for control of single- or double-acting cylinders. Write for bulletin 34-MD with complete specifications of all types.

HANNIFIN
MANUFACTURING COMPANY
621-631 South Kolmar Avenue
Chicago, Illinois

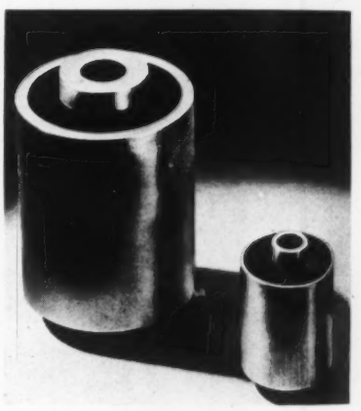
•

HANNIFIN VALVES

New PARTS AND MATERIALS

Mountings Combine Steel, Neoprene

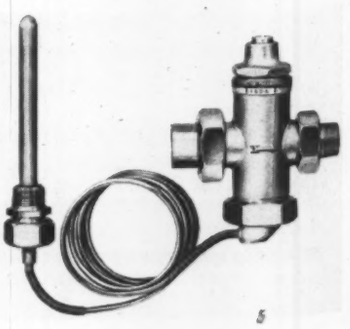
LINE of "Torflex" aircraft engine and cowl mountings is announced by Harris Products Co., 5423 Commonwealth avenue, Detroit. They employ neoprene for resistance to oil and ozonal attack at high altitudes and stainless steel for resistance to corrosive effects of salt air at low altitudes. The mountings, while originally designed for aircraft use, are also available for industrial applications. A mechanical rather than a chemical bond between the neoprene and stainless steel is provided by stretching and compressing a tube of seamless neoprene between inner and outer tubes of stainless steel, the force thus exerted providing sufficient pressure to form a mechanical bond. Capacity rating of the mountings is approximately 150 pounds per square inch axial load.



Mechanical instead of chemical bond between neoprene and stainless steel is provided in new mountings

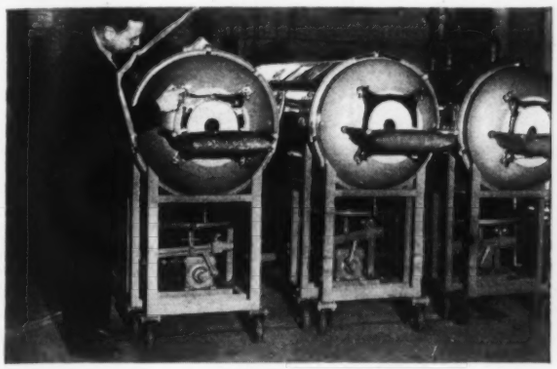
Valve Controls Steam, Water

TO REGULATE flow of steam or water, Model No. 150-A has been added to the line of self-contained, self-operated thermostatic control valves made by Sterling Inc., 3655 North Holton street, Milwaukee. This model is suitable for pressures up to 30 pounds and is

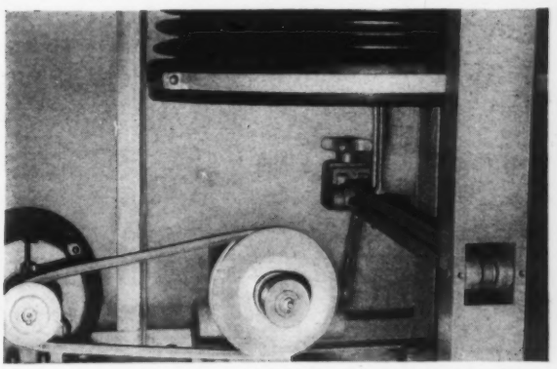


Thermostatic control valve for steam or waier closes on rise in temperature

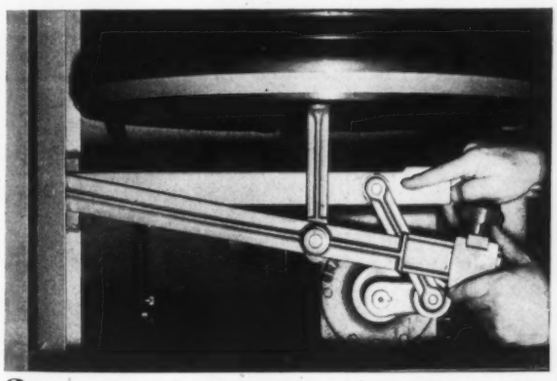
"IRON LUNG" ASSURED QUIET, NEVER-FAILING PERFORMANCE BY TORRINGTON NEEDLE BEARINGS



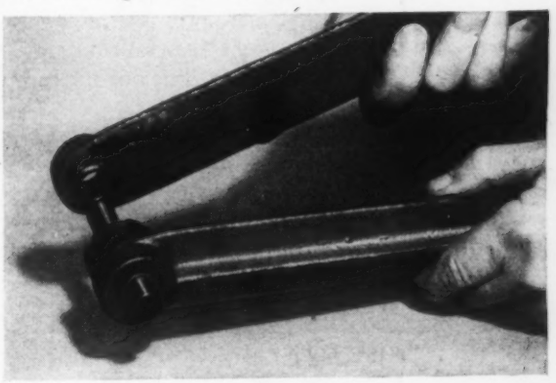
1 Few if any machines must be as absolutely dependable as the famous Drinker-Collins Respirator or "Iron Lung." "Torrington Needle Bearings are used at 4 vital points," says Mr. Herman P. Roth of Warren E. Collins, Inc., the manufacturer, "because they run smoothly and silently day in and day out, year in and year out without attention and without wear."



2 Bellows, which produce an intermittent reduction in air pressure, are driven by a stem, two levers, and connecting rod, all of which move on Torrington Needle Bearings. "Needle Bearings perform admirably," Mr. Roth reports. "They were adopted after previous types of bearings gave trouble due to wear, play and noise when in long-continued service."



3 "The Needle Bearings," continues Mr. Roth, pointing to connecting rod bearing which receives the hardest service, "are lubricated at the time of installation and thereafter require little or no attention throughout the life of the machine." Outer race provides large reservoir for storage and retention of grease and oil.



4 Note that the Needle Bearings occupy no more space than plain bushings! Yet these simply designed, lightweight, and inexpensively installed units give antifriction performance at high speeds under both oscillating (as above) and rotating loads in hundreds of modern products.

If you are looking for ways to increase the efficiency of your product, and still keep costs and space requirements low, the Torrington Needle Bearing may be the answer to your problem. Our Engineering Department will be glad to work with you in incorporating the advantages of the Needle Bearing in your product. For more detailed information, write for Catalog No. 109. For Needle Bearings to be used in heavier service, ask our associate, Bantam Bearings Corporation, South Bend, Indiana, for a copy of Booklet 103X.

THE TORRINGTON COMPANY, TORRINGTON, CONN., U. S. A. • ESTABLISHED 1866

Makers of Needle and Ball Bearings

New York Boston Philadelphia Detroit Cleveland Chicago London, England

TORRINGTON NEEDLE BEARING

Safe Deposit Box FOR AN IDEA!

No modern vault can protect your drawings from the ravages of time! Tracing cloths that turn brittle and opaque with age destroy thousands of dollars worth of drawings annually.

Don't just *hope* this won't happen to you! Specify Arkwright on your next order of tracing cloth, *and be sure!*

Sure of a tracing cloth that is clean, transparent, free from pinholes, thin yet strong – with a surface the way you like it. *More important:* Arkwright Tracing Cloths stay this way! So to give your ideas safe deposit protection, insist on tracing cloths made by America's oldest tracing cloth manufacturer. Arkwright Finishing Co., Providence, R. I.

Write for a free copy of our new catalog.

Arkwright
TRACING CLOTHS

available in sizes ½, ¾ and 1 inch. The valve closes on a rise in temperature, and is sensitive within 1½ degrees Fahr., plus or minus. Standard bulb is copper for immersion in noncorrosive liquids, but bulbs with protective shields of special metals or plating are available.

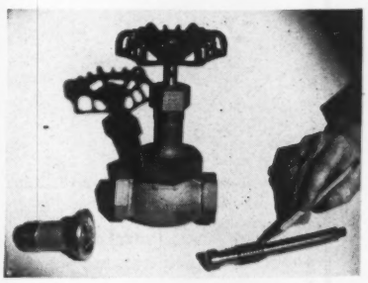
Fan-Cooled Motors Improved

IMPROVEMENTS in its line of totally enclosed fan-cooled motors are announced by Century Electric Co., 1806 Pine street, St. Louis. With a smoother, more symmetrical surface, these motors are finished in machine gray to blend with machines. A generous quantity of cooling air is forced through the large air passages by the nonsparking fan. The air intake passages will not clog easily yet are so designed that a 5/16-inch rod will not pass through them.

A nonsparking fan forces air through large passages in redesigned fan-cooled motors

Valve Stem Alloy Resists Wear

FOR valve stems and bonnets a self-lubricating alloy, Hancodur, is announced by Hancock Valve division, Manning, Maxwell & Moore Inc., Bridgeport, Conn. With a tensile strength of 90,000 pounds per inch, Hancodur stems resist galling and wear and are claimed to outlast other similar parts six times. This alloy was developed expressly for use in Hancock superfinished "500 brinell" bronze valves.

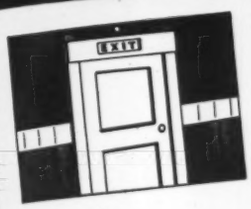


Valve stems and bonnets made from new alloy resist galling and wear

Engines Added to Line

TWO additions to its line of small gasoline engines are announced by Briggs & Stratton Corp., Milwaukee. Model U is rated at 1 horsepower, with a speed range of 2200 to 3200 revolutions per minute. It has a 2 by 2-inch bore and stroke with a piston displacement of 6.28 cubic inches. The five-pint fuel tank is mounted vertically beside the cylinder block instead of on top, reducing the overall height. This model also comes with gear reductions of 6 to 1 and 2 to 1. Model N has the same piston displacement but is rated at 1.5-horsepower with a speed range of 2600

Which of these applications of G-E Neon Glow Lamps can you use?



Exit Lights

Red-sprayed neon Glow lamps provide excellent signals for exit lights and markers.

Soldering Irons, Etc.

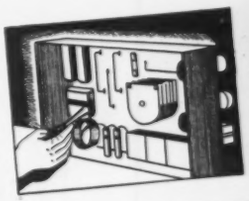
Glow lamps make excellent pilot lights for the economical operation of glue pots, soldering irons, electric furnaces, and other current-consuming devices.

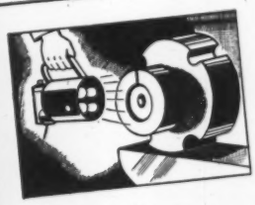
Night Lights

The Glow lamp may be used as a night light around the home, in the bedroom, bathroom, and nursery. A great convenience in the sick room.

Test Lights

As test lights, Glow lamps answer questions about doubtful circuits such as polarity, D.C. or A.C., frequency, etc.



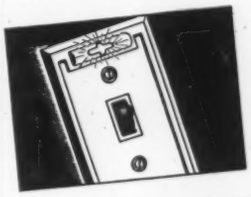


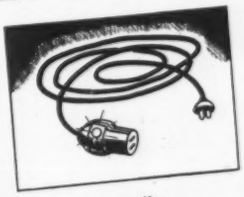
Motor Speed Tests

From a chalk mark on the end of a motor shaft rotating under stroboscopic light from Glow lamps, "slip" can be measured easily.

Wall Switch Indicators

Glow lamps not only indicate whether the switch is on or off but also act as a guide light to switch when room is dark.



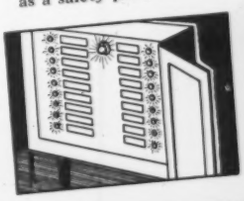


Connector Bodies

Glow lamps incorporated in connector bodies of extension cords help to isolate the trouble when electrical appliances refuse to operate.

Panelboard Indicators

As panelboard indicators, dependability and long life of Glow lamps makes them useful to indicate whether the panel is "hot" or not as a safety precaution.

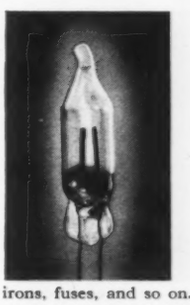


GENERAL ELECTRIC NEON GLOW LAMPS offer electrical equipment manufacturers a new, inexpensive means for providing their products with extra sales features. Some of the applications shown above may suggest possible uses in equipment you manufacture.

Glow lamps are unique in many characteristics. Their light is produced through the agency of electrically excited rare gases, yet they operate directly from commercial lighting circuits.

Because they have no filament, they produce a negligible amount of heat, withstand both shock and vibration to an unusual degree, and may be subjected to voltage variations without greatly affecting either their life or light output. The characteristic orange-red color of the neon lamp causes it to stand out from other surrounding light sources.

For a handy folder on G-E Neon Glow Lamps suggesting a few of their hundreds of uses, write address below. Your electrical wholesaler or jobber carries a complete line of these lamps.



THIS 1/25TH WATT G-E NEON GLOW LAMP HAS MANY APPLICATIONS

Like other G-E Neon Glow Lamps, it is rugged, long-lived, and dependable. Its size (maximum overall length is $1\frac{1}{16}$th" and width ¼") makes it applicable to electrical devices where small size is a factor, as in controls, connector plugs, and small domestic appliances such as toasters, curling irons, fuses, and so on. Because it takes only 1/25th of a watt, the heat generated is negligible. Hence it is adapted to use in enclosed spaces.

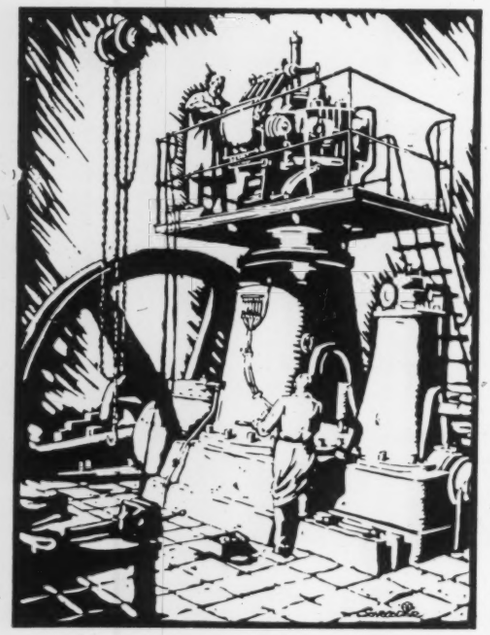
G-E Neon Glow Lamps, now in use in millions of electrical devices, have been giving continued satisfaction for years . . . in fact 10 years' service is not unusual.

This 1/25th watt lamp, without a resistance, now lists at a new low price of **only 8 cents!**

NELA SPECIALTY DIVISION, LAMP DEPARTMENT

GENERAL ELECTRIC

410 Eighth St., Hoboken, N. J.



INVENTIVE GENIUS DESERVES PROTECTION

. . . and the Government offers this protection.

What is patentable? . . . What is infringement? . . . What primary steps are necessary for protection? . . . How are disclosures made? . . . and the thousand and one other questions that confront the layman, the engineer, the business man . . . all are answered in this single, conveniently indexed volume.

"Inventions and Their Protection"

Hundreds of copies of this book are already in daily use in designers' offices . . . they are the guide-books for foresighted engineers who want to protect themselves and their employers. This book may well pay for itself in answering any question that arises.

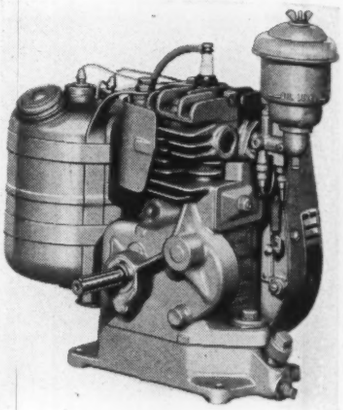
JUDGE FOR YOURSELF . . . ORDER A COPY FOR FREE EXAMINATION

You can judge the worth of "Inventions and Their Protection" for yourself, without obligation. Order a copy today on ten days approval. If, after ten days, you are not satisfied, return it in good condition and your bill will be canceled. If you wish to send payment with your order, postage will be prepaid.

"INVENTIONS AND THEIR PROTECTION": by George V. Woodling; 316 pages; fully illustrated; bound in blue cloth; $5 postpaid (plus 15c to cover compulsory state sales tax for copies to be delivered in Ohio).

THE PENTON PUBLISHING CO.
Book Department
1213 W. Third Street Cleveland, Ohio

to 4000 revolutions per minute. It is available in special types incorporating the following features: Gear reductions of 6 to 1 and 2 to 1; direct mounting crankcase, machined and tapped, with ball bearings on the drive side. Both models are aircooled, 4-cycle, L-head

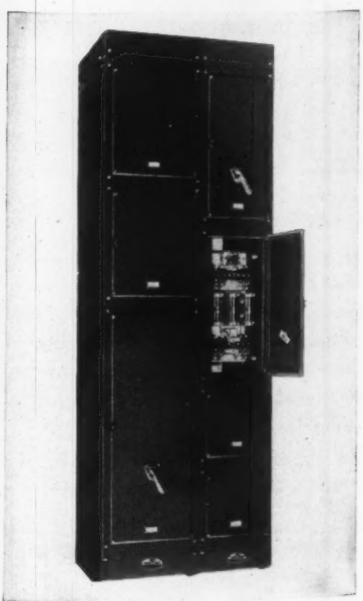


Piston displacement of two new engines is the same, but raiings and speeds vary

design. A patented high tension magneto is built into the flywheel and a pump supplies lubrication to all moving parts. Connecting rods and pistons are durable aluminum alloy to reduce weight and increase efficiency.

Control Devices Centralized

PERMITTING all types of control devices to be organized in locker-like motor control centers, the Unitrol sectionalized motor control announced by Cutler-Hammer Inc., Milwaukee, is built on the same principle as sectional filing cabinets. Standardized construction allows quick building up of any Unitrol control center to meet requirements, without special engineering. Control



Control units are mounted in standardized cubicles in sectionalized motor control

units are mounted in standardized cubicle sections, made in 32 sizes. Units can be mounted in both front and rear of the section, giving double-sided construction and an economy of space hitherto unknown. Sec-

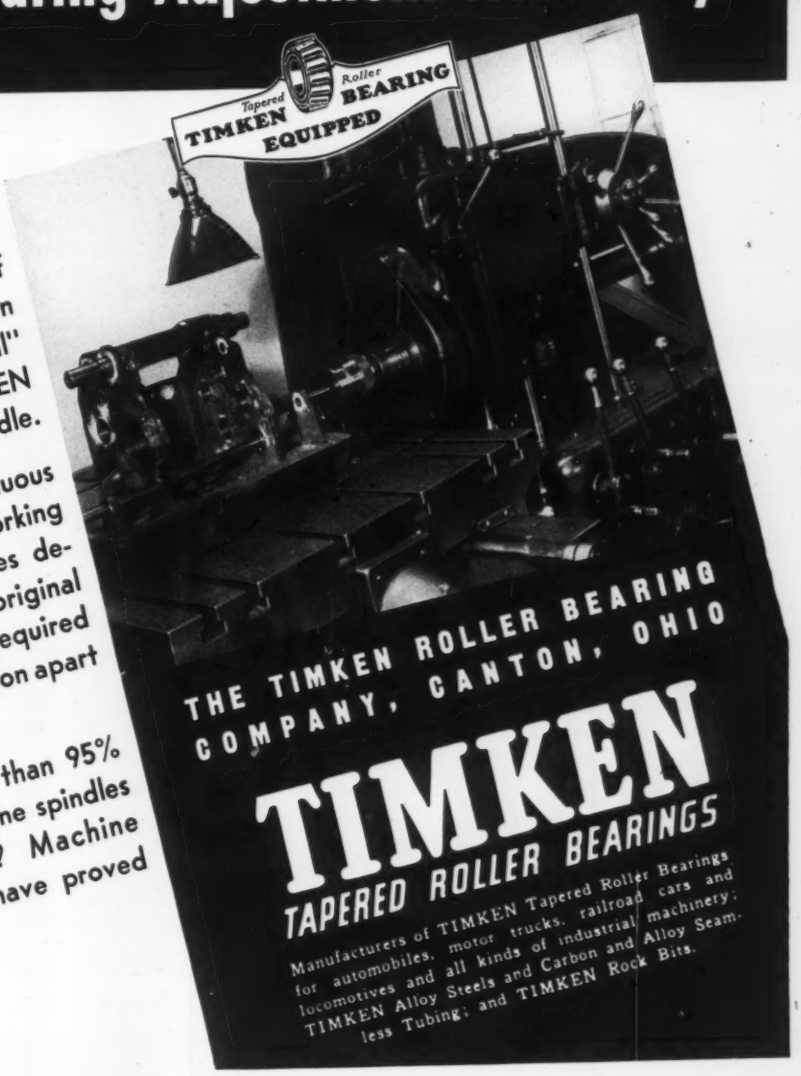
OVER
12
YEARS' SERVICE

ON TIMKEN BEARINGS
No Bearing Adjustment Necessary

THIS Number 24 Tri-Way "Universal" Boring Machine was placed in service in June 1928 in the plant of a leading manufacturer of precision equipment. It was the first "Universal" machine to be equipped with TIMKEN Tapered Roller Bearings on the spindle.

After more than 12 years of continuous operation it still is capable of working to the extremely close tolerances demanded by the user, and the original TIMKEN Bearings have not required any adjustment or other attention apart from lubrication.

Is it any wonder that more than 95% of all new heavy-duty machine spindles go on TIMKEN Bearings? Machine manufacturers and users have proved it pays to have them.



THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN
TAPERED ROLLER BEARINGS

Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; and TIMKEN Rock Bits.

"HERE'S THE ONE THAT STAYS, LAD— WHEN OTHERS GO!"

"Every once in awhile, somebody brings out a vellum tracing paper that's supposed to be as good as Bruning Vellux. I've seen plenty of them come and go. But you notice we're still standardizing on Vellux, because it meets every test on the drafting board and in the file."

* * *

Why has Bruning Vellux maintained its leadership for 21 years? Because it has proved its consistent transparency on the drafting boards of the nation—proved that it meets every test for erasing, durability, lasting whiteness, pliability and printing effectiveness.

If you haven't tried Vellux, find out why it's first choice of so many experienced draftsmen. Mail the coupon for a generous, free working sample.

BRUNING *Since 1897*

SPEEDS—SIMPLIFIES—AND PROTECTS A NATION'S DRAFTING

New York • Chicago • Los Angeles • Boston • Detroit • Houston • St. Louis Kansas City • Milwaukee • Newark • Pittsburgh • San Francisco • Seattle

1114-203

CHARLES BRUNING CO., *Inc.*
New York: 100 Reade St.—Chicago: 445 Plymouth Ct.
Los Angeles: 919 So. Maple Avenue

Gentlemen: Please send me a generous working sample of Bruning Vellux—the better vellum.

Name .....

Company .....

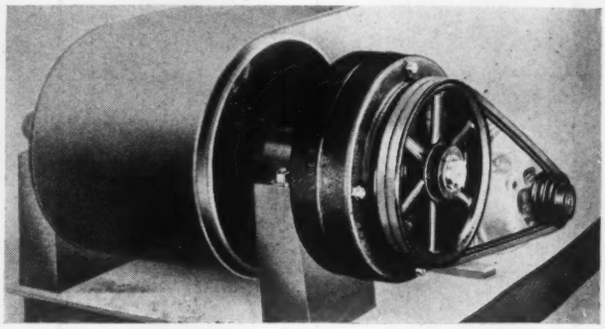
Address .....

City ..... *State* .....

tions may be installed in a straight line, an L-shape or a U-shape. Blank steel panels are furnished for any unused sections, and pushbuttons, meters and other accessories may be mounted on the blank panels.

Reduction Unit Needs No Base

EACH involving a 13 to 1 ratio, five sizes are offered in the line of reduction drives announced by American Pulley Co., 4285 Wissahickon avenue, Philadelphia. Mounting the reduction unit on the driven shaft, these drives are suitable for ½ to 30-horsepower. V-belt connection to a driving motor provides for further variable reduction of speed between the motor and the driven shaft. Characteristics of the drive include elimination of a foundation for the geared reduction, protection

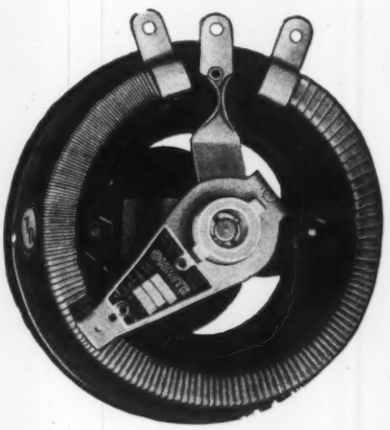


Five sizes are offered in line of reduction drives

offered by the belt against shock loading, and permanent maintenance of alignment between reducer and driven shaft. Following application on a drive, the outer case is equipped with a torque arm or connection, to keep it from turning. This is not shown. The arm is attached between one of the bolts on the outside of the drive case and a convenient rigid part of the machine.

Generator Voltage Controlled

SMOOTH, close, gradual control of generator voltage is provided by the generator field control rheostats announced by Ohmite Mfg. Co., 4835 Flournoy street, Chicago. These rheostats are tapered or uni-



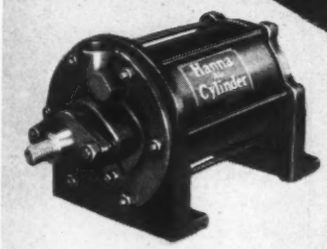
Available in ten wattage sizes, rheostats are tapered or uniformly wound

formly wound, as required, and are designed to provide control for separately or self-excited generators. They are available in a series of ten wattage sizes,

WATCH THEM WORK!

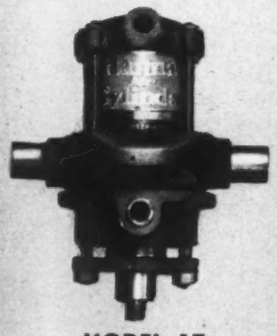
. . . You'll SEE the smooth, dependable power you've designed into your machines with

Hanna Cylinders



MODEL 4

MODEL 14



MODEL 17

ON your drafting board, all cylinders may look alike — but if you could watch the machines you design in which Hanna Cylinders are used, you'd see that their fast, dependable operation provides the kind of performance you planned. In your own plant, too, there are probably many jobs that could be handled faster — better — and at less cost with Hanna Cylinders.

For example, the practicability of Hanna Cylinders has been demonstrated in improving the operation of equipment such as presses — shears — clutches — valves — brakes — strip reel pushers — hopper gates — furnace and oven doors — material handling equipment — assembly fixtures — furniture clamps — damper regulation — hoists — any place where a push or pull is needed, either directly or through levers or toggles.

Hanna Cylinders are built in a wide range of sizes, for pneumatic or hydraulic operation. Write for complete details.

HANNA ENGINEERING WORKS

1772 ELSTON AVENUE • CHICAGO, ILLINOIS

Air and Hydraulic RIVETERS | **Air HOISTS** | **Air and Hydraulic CYLINDERS**

When You Specify

BARNES HYDRAULICS

You buy more than equipment—you buy an engineered application. Designed and built for the job to be done.

As designers and builders of hydraulic units, panels, control valves, and pumps for manufacturers in a wide range of industries, we are in excellent position to solve your hydraulic problems and supply the necessary equipment.

And what's more—users of Barnes Hydraulics over a period of many years under most severe operating conditions report maintenance costs at an absolute minimum—lowest by comparison.

That's why careful buyers specify

BARNES HYDRAULICS

Send us your inquiries with information about the job to be done. We'll be glad to submit a proposal or if you say so, we will have an engineer call.

JOHN S. BARNES CORPORATION

DETROIT SALES OFFICE
503 NEW CENTER BLDG.
TR. 1-1706

MAIN OFFICE
AND FACTORY
ROCKFORD, ILL.

Felt...

—the Universal MATERIAL

Every day, designers and plant men, faced with a new or unusual problem, are finding the answer in felt. Working closely with Western's research laboratories, these men have discovered highly specialized uses for felt with greater efficiency and economy.

Among the more common uses for felt are in vibration absorption, sound deadening, heat insulating, sealing bearings, conveying lubricants, filtering liquids.

Wherever you are, Western's complete laboratory facilities and 41 years of practical experience are yours for the asking, with no obligation.

Western Industrial Felt Service

WESTERN FELT WORKS

4037-4117 Ogden Ave., Chicago, Illinois

Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felts. Established 1899.

BRANCH OFFICES IN ALL PRINCIPAL CITIES

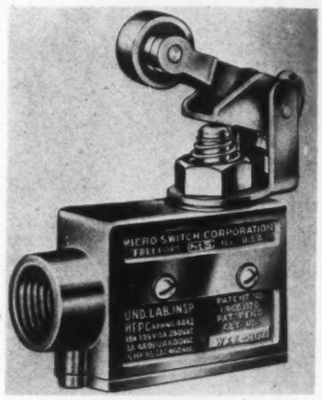
from 25 to 1000 watts. Compact, vitreous-enameled construction insures permanently smooth operation and exact control, and by providing practically continuous variation of resistance in even the smallest sizes, considerable saving in space is effected.

Tubing Is Varnished Inside

WITH a smooth inside surface, Irv-O-Volt varnished inside-and-out tubing is announced by Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. It combines extreme flexibility with high tensile strength and has superior moisture resistance and aging properties. It will not soften, blister or flow, its maximum heat endurance when tested being 425 to 450 degrees Fahr. for 15 minutes. Black and yellow colors are standard, with green, red and blue also available.

Switch Widely Adjustable

METAL-CLAD micro switch with a roller arm adjustable vertically through an arc of 225 degrees around its pivot pin and adjustable horizontally in eight positions 45 degrees apart, is announced by Micro Switch Corp., Freeport, Ill. Roller arm is a lightweight aluminum die casting with a roller carried on an oilless bronze bearing. The roller arm bracket is used



Roller arm bracket in switch is used in connection with regular metal-clad micro switch

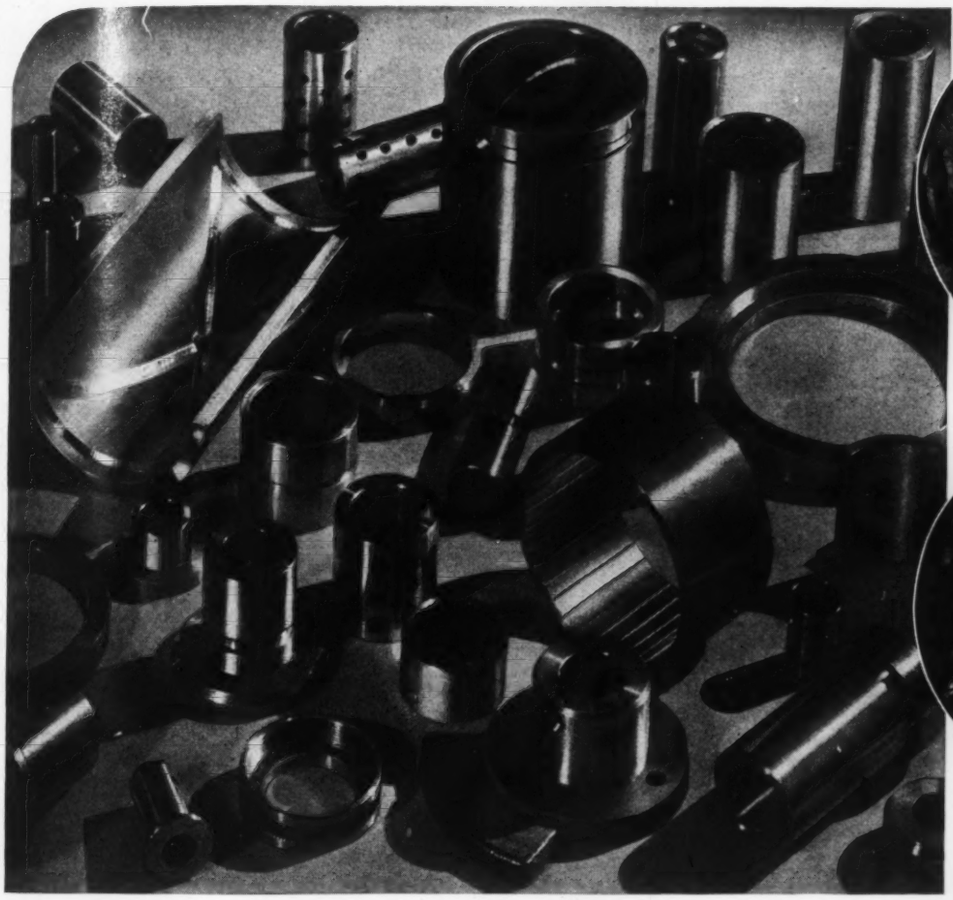
in connection with the regular metal-clad micro switch. The switch is rated at 1200 watts up to 600 volts alternating current and is single-pole only, with normally closed, normally open, or double-throw contact arrangements.

Announce Electric Equipment

FOR use with portable electric equipment, a line of heavy duty plugs, receptacles and cord connectors is announced by the Pyle-National Co., 1334 North Kostner avenue, Chicago. All 2, 3 and 4-pole contact units are interchangeable, and contact units are reversible, for safety protection. Contact units are molded plastic with renewable self-aligning flat bronze contacts and side-wired binding screw terminals. Three and four-pole contact units can be furnished with one pole grounded for installations requiring an equipment ground wire.

Paint Resists Corrosion

RECOMMENDED for service under extremely corrosive conditions, a grade of Koroseal paint, named Koroplate, is announced by the B. F. Goodrich Co., Akron, O. The new paint is liquid at room temperatures and requires no heating before application. At



Chemical Testing to Check Metal Analysis

Micro-photographing the Grain Structure

Brinnell Testing for Surface Hardness

Buckeye COMBINES THE SIZE, SHAPE AND METAL ANALYSIS YOU NEED AND THE DEPENDABILITY YOU WANT

● Available in any conceivable combination of I. D.s, O. D.s and lengths, and in any desired bearing metal analysis; slotted, split, drilled or threaded; with or without lugs, flanges, collars, etc., Buckeye "Specials" meet any blue print requirement. Each is a quality product manufactured from virgin metal under Buckeye's exacting laboratory and metallurgical control that maintains the accuracy of metal analysis and dimension—assuring easy assembly and long, efficient service. We set—and maintain—high manufacturing and inspection standards to serve you better. That's why Buckeye "Specials to customer's blue print," Buckeye's 1088 sizes standard fully finished ready-to-use bearings, Buckeye's graphited bearings, etc., are so widely used throughout all industry. A trial order will convince you of the desirability of standardizing on Buckeye bearings. We solicit your inquiries which will have our prompt and courteous attention. Let us quote on your requirements.

No order is too big or too small for Buckeye

Buckeye

THE PRECISION-MADE LINE

Ready-to-use industrial bearings, 13" semi-finished bars, and electric motor repair bearings, are stocked throughout the country for your convenience—Also rough bars, graphited bearings and "Specials" made exactly to customer's blue print—Each is a quality precision-made product.

Standardize on Buckeye Bearings

Buckeye

BRASS AND MANUFACTURING COMPANY

BRONZESMITHS SINCE 1900

6412 HAWTHORNE AVE. CLEVELAND, OHIO

FULLER STEELGRIPT

THE MULTI-PURPOSE BRUSH CONSTRUCTION

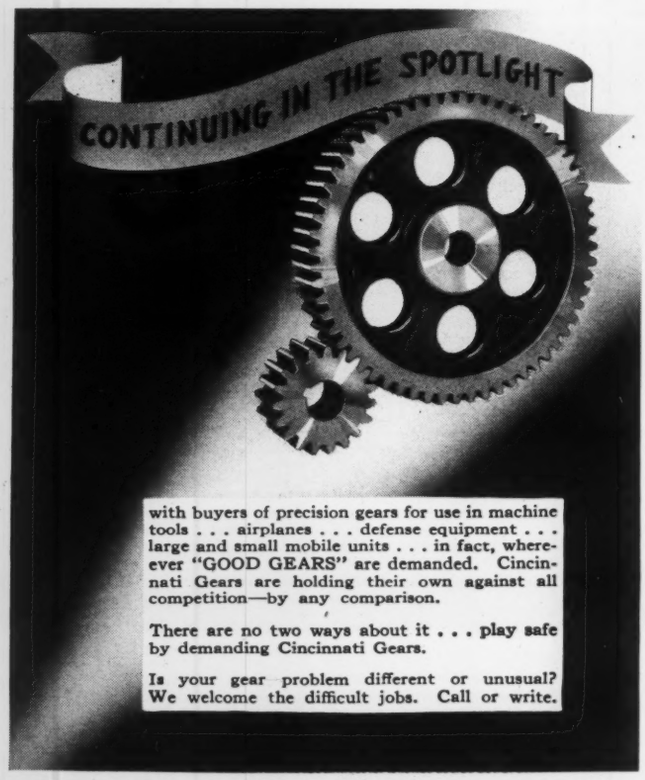
DESIGNERS and Builders of machinery and equipment, utilizing brushes as an integral unit, approve Fuller Steelgript's enduring construction. Brush material is held, vise-like, in a durable, rust-resisting, all metal backing—no wood. Manufactured in strips, cut to specified lengths, it can be formed, shaped and spiraled to your requirements.

Steelgript's strong, rigid, metal backing requires only simple attachments for fastening into machinery. Replacements with refills quickly made.

Patented Fuller Steelgript is widely used on Packaging and Labeling equipment, Printing Presses, Bus and Car washers, Textile, Steel and Tin production, Power Sweepers. Also used by Food, Bakery and Candy Manufacturers, Dairies, Bottlers, Flour Mills, Meat Packers and others.

Send your blue prints and specifications for quotations on your particular requirements

The **FULLER BRUSH** Company
INDUSTRIAL DIVISION DEPT. 8C
3589 MAIN STREET · HARTFORD, CONN.



with buyers of precision gears for use in machine tools . . . airplanes . . . defense equipment . . . large and small mobile units . . . in fact, wherever "GOOD GEARS" are demanded. Cincinnati Gears are holding their own against all competition—by any comparison.

There are no two ways about it . . . play safe by demanding Cincinnati Gears.

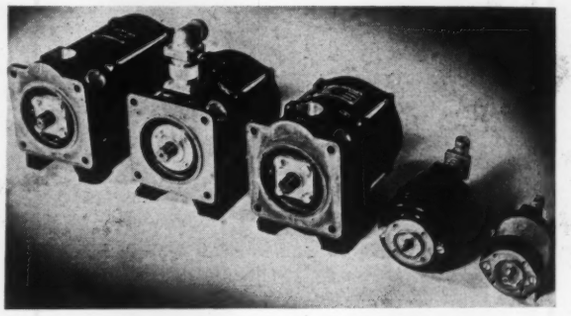
Is your gear problem different or unusual? We welcome the difficult jobs. Call or write.

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
1827 Reading Road · Cincinnati, Ohio

ordinary temperatures it can be either brushed or sprayed and can be thinned with either brush or spray thinners. It is made only in semi-glossy black. When thoroughly dry the paint is extremely resistant to the action of fumes and vapors from acids, alkalies and salts at room temperatures or slightly above. It resists all acids except concentrated formic and acetic and is not affected by brass, chromium, nickel, cadmium, zinc, copper, silver or tin plating solutions.

Motors Are Light, Compact

DIRECT current aircraft motors that combine lightness and compactness with high power output from 1/100 to 3-horsepower are announced by Air Associates Inc., Bendix, N. J. These motors are built according to U. S. Army specifications with standard size mounting pads, shaft fittings, and terminal connections or with special fittings for commercial applications. They are designed primarily for aircraft power needs such as operation of hydraulic and fuel pumps, landing gear retracting mechanisms, tow target winches, anti-icing equipment, wing flaps, and many



Aircraft power needs such as operation of fuel pumps, landing gear and wing flaps are met by new motors

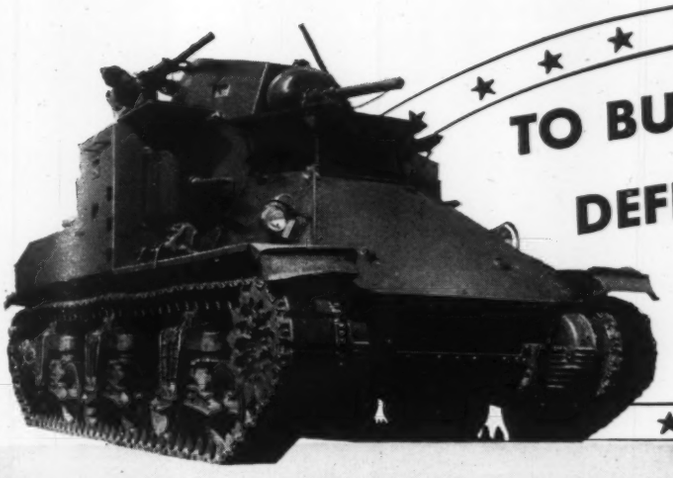
other uses. Magnesium alloy castings are used for the motor frame to reduce weight, and the motors are insulated for high operating temperatures with fiber glass and special heat resisting varnish. All models are radio-shielded and shafts are mounted in ball bearings. Motors are available in 6, 12, and 24-volt models for continuous or intermittent service. They may be series or shunt-wound, and of explosion-proof, forced draft or internal fan construction.

Visible Oiler Is Dust-Proof

A VISIBLE, unbreakable oiler announced by the Trico Fuse Mfg. Co., 2948 North Fifth street, Milwaukee, is intended for applications of gravity feed

Foreign matter cannot pass the fine mesh brass screen and felt filter in gravity feed oiler

oilers where the dust-proof feature is desirable. No foreign matter can pass the 100 mesh brass screen and



TO BUILD BETTER DEFENSE PRODUCTS QUICKER

AIRCO

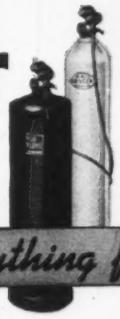
Specimen flame hardened tooth. Note uniform depth of hardness.

Typical example of how a sprocket tooth is quickly flame hardened.

FLAME HARDEN SPROCKET TEETH

Defense products are now being built faster—and better—because manufacturers are utilizing one or more of the many time-saving oxyacetylene processes and products. As an outstanding example—sprocket teeth and other vital wearing parts are being flame hardened. Flame hardening is usually accomplished in a fraction of the time required for other hardening methods, and since it is performed on finished surfaces, machining and regrinding operations are considerably reduced.

The oxyacetylene Flame Hardening Process hardens wearing surfaces without materially affecting the physical properties of the core. It gives you all the benefits of other surface hardening methods. Yet it is applied with the speed, flexibility, simplicity and economy typical of all applications of the oxyacetylene flame. An added advantage—it permits hardening surface contact areas which could not otherwise be treated due to size or shape of the section. » » » Bring your surface wear problems to Airco. Members of our Applied Engineering Department will gladly assist Airco customers with practical advice. Write for full details.



Air Reduction

General Offices: **60 EAST 42nd ST., NEW YORK, N. Y.**

DISTRICT OFFICES IN PRINCIPAL CITIES

AIRCO

WILSON

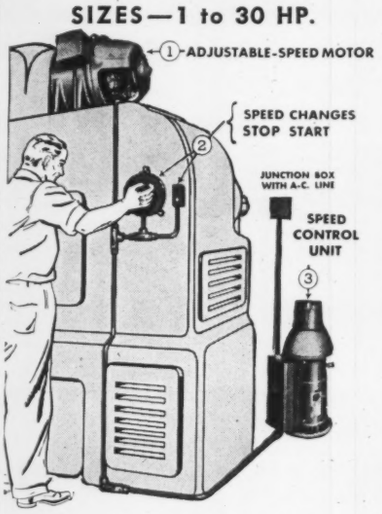
Anything and Everything for **GAS WELDING or CUTTING and ARC WELDING**

SPEED RANGES UP TO 16 TO 1

RELIANCE V*S DRIVE

AN ALL-ELECTRIC ADJUSTABLE-SPEED DRIVE FOR A-C. CIRCUITS

SIZES—1 to 30 HP.



1. A DIRECT DRIVE. Fewer parts and less space because the drive is direct—there's no intermediate speed-changing device.

2. CONTROL—Within easy reach. There's nothing to limit convenience. Put speed adjuster and start-stop button in a handy spot and run a wire to them.

3. FROM A-C. POWER CIRCUIT. The many advantages of this drive are made possible at a new low price by the "packaged" V*S Speed Control Unit which is connected by three wires to a 3-phase a-c. power circuit.

ALSO—Quick stopping, reversing, safe speeds for threading, ample starting torque with smooth acceleration, speed setting. Get Bulletin 309 for details.

RELIANCE ELECTRIC & ENGINEERING CO.

1079 IVANHOE ROAD • • CLEVELAND, OHIO

Sales Offices in Principal Cities

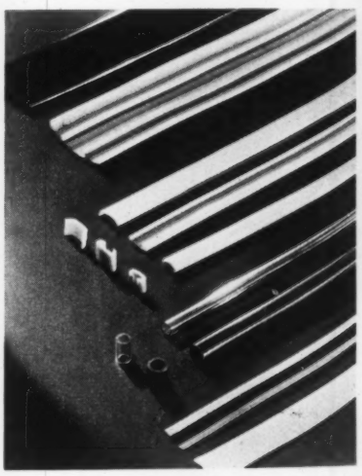
felt filter. The filter can be removed for cleaning. Mounted at the top of the part to be lubricated, the oiler can be set for any predetermined number of drops of oil per minute by an adjustment of the needle valve. This oiler is 50 per cent lighter in weight and there are no gaskets to leak, since the unbreakable bottle is cemented and roll-clinched to the heavy brass base. The oiler is made in four styles, available in one, two, four and eight-ounce capacities.

Varnish Cures Rapidly

IMPROVEMENTS in speed of cure and flexibility are claimed for a new formulation of Harvel 612-C insulating varnish announced by Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. An internal drying varnish that solidifies throughout, Harvel 612-C polymerizes upon baking to an infusible, insoluble state.

Plastics Extruded Continuously

PERFECTION of a new process for extruding plastics is announced by Detroit Macoid Corp., Detroit. It is possible with this process to manufacture individually designed moldings, tubing, rods, etc., in continuous lengths. These extruded shapes are obtainable in a wide assortment of colors and are available in either opaque, translucent or transparent forms.



Extruded plastic shapes are obtainable in a wide assortment made by new process

Flexing Life Doubled in Cord

FLEXING life is doubled and stripping is made easier by new construction of CordX cord, announced by Construction Materials division, General Electric Co., Bridgeport, Conn. A bias cotton wrap is placed directly over the cord and vulcanized into the inner surface of the rubber jacket. This wrap supplies an antifriction surface between the jacket and the rubber-insulated conductors. All other materials of the cord contribute to its flexibility and durability. Conductors are made of many fine strands of fine annealed copper and a cotton separator is applied directly over the copper to prevent corrosion and relieve strain on the wires.

Range Switch Redesigned

REDESIGNED combination range switch announced by Square D Co., Detroit, has 60-ampere two-pole main and range circuits and four one-pole plug fusible circuits. Devices with parallel main and range switches

PLASTICS
Can Deliver

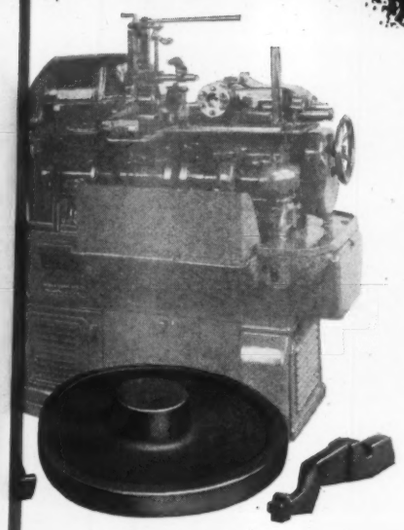
■ American Industry, cooperating wholeheartedly with the National Defense Council, is confronted with the greatest production problem it has ever faced. A problem of speedy production of a vast amount of rearmament equipment and supplies at a time when machinery is at a premium, when there is a shortage of skilled labor and a scarcity of some essential materials. In addition, Industry faces the problem of carrying on the uninterrupted production of peacetime requirements and of preparing to meet the intense competition bound to occur when peace is once more restored. New products must be developed—old products re-designed and other materials employed in place of those required exclusively for defense purposes. » » Fortunately, most Plastic Materials can be supplied in quantities sufficient for both defense and peacetime requirements. » » Design Engineers should therefore give careful consideration right now to the use of PLASTIC MOLDED PARTS in solving their production problems.

Our Engineering Staff will cooperate with you on this.

CHICAGO MOLDED PRODUCTS CORP.

1028 No. Kolmar Ave. Chicago, Illinois

CHECK The "QUALITY ADVANTAGES" Required For Any Part With Those OFFERED BY FORGINGS



Manufacturer of Brown & Sharpe Machine Tools uses forgings to facilitate rapid production. On their Universal Milling Machines, they used forged gears to provide uniform gear tooth strength and satisfactory machining quality. On the Automatic Screw Machines, a forged chuck lever effectively protects the chuck feed mechanism against breakdown because, being forged and then heat-treated, it has the plus-strength required for such a part. On their Wire Feed Hand Screw Machines, forgings are employed to good advantage in the assembly of an indexing turret which is automatically locked when a new tool position is reached. The turret locking hand lever is a forging providing maximum wear resistance.

7 "QUALITY ADVANTAGES" OF FORGINGS:

1. **Strength:** plus tensile and torsional strength.
2. **Uniformity of Physical Properties:** obtainable in forgings in the exact degree desired.
3. **Weight Reduction:** through maximum strength and lighter sectional thicknesses.
4. **Welding Adaptability:** widest range for fabricating complicated parts from two or more forgings.
5. **Lower Machining Costs:** forgings shaped in closed dies require a minimum of machining and finishing.
6. **Safety:** through freedom from concealed defects.
7. **Endurance:** forgings provide high fatigue resistance which insures dependable performance over longer periods of use.

mpactness and minimum weight are realized in Eclipse rcraft Engine Starters by the use of these forged parts: rter driving jaw, starter bell crank, motor strap "T" bolt, rter flywheel dog, and motor engaging jaw. The manuturer of this starting unit cites this benefit: "A final vantage is lower machining costs. With forgings, our chining scrap is reduced to a minimum because, being ped in closed dies to close tolerances, there's no excess tal bulk to be removed."

The forged gear parts illustrated assure the uninterrupted performance of the Standard Fluid Process Duplicator —a precision built duplicating unit which makes 200, and more, copies without the use of gelatin, stencil, type, or ink. This manufacturer had three vital factors to consider in making these forged gears: (1) hardenability. (2) core properties, (3) freedom from distortion. By using forgings, it was possible for this manufacturer to obtain uniformity of physical properties in the exact degree desired.

HELPFUL SUGGESTIONS

"Drop Forging Topics" presents actual applications of forgings in a wide variety of types of equipment and tells the advantages and economies derived from the use of forgings by various manufacturers. "Drop Forging Topics" is sent free to engineers, designers, metallurgists, production and management executives. If you are not receiving it, send us your name today. It's free.

HERE ARE NO SUBSTITUTES FOR FORGINGS

DROP FORGING ASSOCIATION

605 HANNA BUILDING · CLEVELAND, OHIO

SYMBOLIC EMBLEM OF THE DROP FORGING ASSOCIATION

If Space Is Limited For

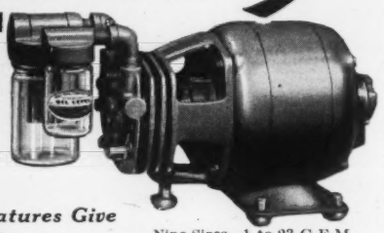
VACUUM PUMPS

ON YOUR MACHINES

Specify This

"GAST"

2NF10-VA ROTARY AIR PUMP



Scores of manufacturers have discovered by *actual comparative tests* that this compact Gast air pump, only 11½" x 6½" in size, solves the problem of limited space *without* sacrifice of economy, performance or durability.

These Famous Gast Features Give You Exceptional Performance

Nine Sizes—1 to 23 C.F.M. Vacuum To 28" Pressures to 30 pounds.

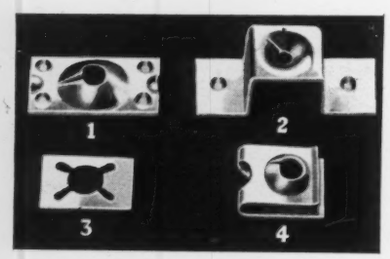
- COMPACT—Vacuum pump and rotor mounted on motor shaft.
- EFFICIENT—More air delivered per pound of weight and H.P. used.
- ADAPTABLE—Can be used as either vacuum or pressure pump.
- DESIGN—Cuts friction loss to a minimum.
- AUTOMATIC OIL SEAL—Eliminates shaft packing . . . Prevents oil leakage, vacuum loss, excessive friction, troublesome adjustments.
- VANES—Composition . . . No springs . . . automatic takeup for wear.
- SIMPLICITY—No gears, springs or reciprocating parts.

Write Today for complete Catalog, Performance Chart and Special Manufacturers' Discounts! **Gast Mfg. Corporation, 107 Hinkley St., Benton Harbor, Mich.**

GAST VACUUM PUMPS

CHOOSE *Prestole* FASTENING DEVICES

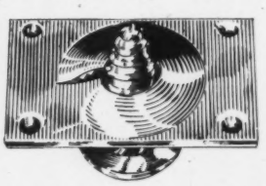
THE *line* OF LEAST RESISTANCE . . .



for TIME and MATERIAL SAVINGS along your assembly lines

★ Build with *more speed* and greater rigidity, at *less cost* by using Prestole Fastening Devices in your assemblies.

Each Prestole Fastening Device made from cold-rolled steel (see items 1, 2, and 4), embodies the conically formed, and scientifically slit thread, which is attained by the *Patented* Prestole method of pre-tapping.



This Prestole is made of .050 cold-rolled steel, easy to jig and weld. A sturdy, efficient fastener. More than 40,000,000 used by the automotive industry in 1940. Rapidly finding new places along assembly lines.

CUT COSTS with *Preformed* Prestoles

Your *preformed* Prestole Fastening Devices, with *pretapped* holes, actually *invite* the entrance of the mating screw thread—make it unnecessary for the screw itself to deform the metal—allow for reasonable tolerances in hole alignment and create an assembly with a positive *tension* that stays tight even under abnormal vibration, without the use of a lock washer.

QUICKIES — Item 3 above. Spring push-on nuts. Push over pins, any shape or material, for quick vibration-proof assemblies.

IMMEDIATE DELIVERIES Many items in stock. Specials designed to fit your need. Write

Prestole Sales Division

CENTRAL SCREW COMPANY 3509 SHIELDS AVE. CHICAGO, ILLINOIS

are available. Solderless connectors are furnished throughout, and the plastic base may be reversed. Knockouts are plentiful and there are several new tangent knockouts which permit better electrical bonds and facilitate ganging with other controls.

Tangent knockouts in redesigned combination range switch permit better electrical bonds

Varnish Impregnates Glass Cloth

GLASS cloth, impregnated and coated with heat resisting varnishes developed especially for use as insulation in motors, generators and similar equipment, is announced by Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. Fiberglas is impregnated with a special varnish which greatly increases its resistance to abrasion and impact, and also increases its overall mechanical strength. Since the resulting material has much higher insulation and heat resistance it permits manufacture of lighter, smaller motors for any given horsepower rating. Standard thicknesses are .005 to .012-inch, widths go up to 36 inches, and black or yellow colors are available.

Engineering Dept. Equipment

Printer Is Compact

SIMPLICITY of design and operation is embodied in a new printing machine announced by Charles Bruning Co. Inc., 100 Reade street, New York. Known as the Model 55 BW printer, this machine is said to be the most compact printer of its capacity on the market, measuring only 32 inches wide, 62 inches long and

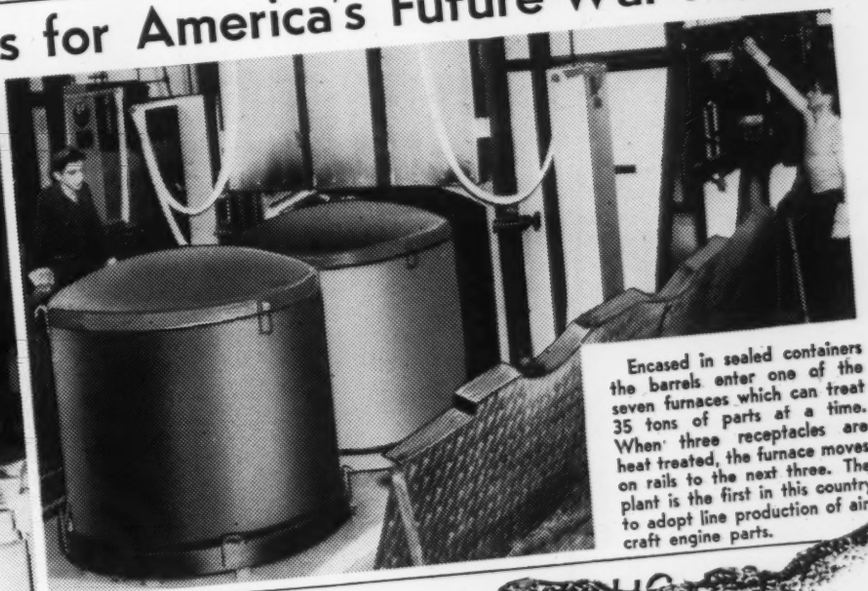
Print and tracing reiurn in compact printing machine causes tracing to enter tray exactly as inserted in machine

ORK WORLD-TELEGRAM, TUESDAY, NOVEMBER 26, 1940.

oughening Up Process for America's Future War Planes

The world's largest battery of furnaces for nitriding—a process which develops one of the hardest steel surfaces known— are toughening airplane cylinder barrels in the Paterson, N. J., plant of the Wright Aeronautical Corp. In this photo the cylinder barrels are being lowered into the furnace.

Acme Photo



Encased in sealed containers the barrels enter one of the seven furnaces which can treat 35 tons of parts at a time. When three receptacles are heat treated, the furnace moves on rails to the next three. The plant is the first in this country to adopt line production of aircraft engine parts.

Britain Makes Bid For Bu

Congr

Gu
If S

By the

Roosevelt Calls
Def

A FEW STANDARD APPLICATIONS OF NITRALLOY

- Calender Rolls
- Cams and Camshafts
- Chain Links and Pins
- Connecting Rods
- Crankshafts
- Cylinder Liners
- Die Casting Dies and Cores
- Fan Blades
- Fuel Injector Parts
- Gears
- King Pins
- Pinions
- Piston Rods and Rings
- Pump Rotors and Sleeves
- Push Rods
- Scale Balances
- Scale Blocks
- Seaming Rolls
- Seats for Valves
- Shackle Bolts
- Shafts
- Sockets
- Spindles
- Splines
- Sprockets
- Steering Worms
- Tappets
- Valve Gauges
- Valve Seat Rings
- Valve Stems and Sleeves
- Water Pump Shafts
- Worms
- Wrenches
- Wrist Pins

Companies Licensed by the Nitralloy Corporation

Allegheny Ludlum Steel Corp.	Watervliet, N. Y.
Bethlehem Steel Co.	Bethlehem, Pa.
Crucible Steel Co. of America	New York, N. Y.
Firth-Sterling Steel Co.	McKeesport, Pa.
Republic Steel Corporation	Cleveland, Ohio
The Timken Roller Bearing Co.	Canton, Ohio
Vanadium-Alloys Steel Co.	Pittsburgh, Pa.

Operating and Accredited Nitriding Agents

Camden Forge Co.	Camden, N. J.
Commercial Steel Treating Corp.	Detroit, Mich.
The Lakeside Steel Improvement Co.	Cleveland, Ohio
Lindberg Steel Treating Co.	Chicago, Ill.
Link-Belt Co.	Philadelphia, Pa.
Met-Lab, Inc.	Philadelphia, Pa.
New England Metallurgical Corp.	Boston, Mass.
Pittsburgh Commercial Heat Treating Co.	Pittsburgh, Pa.
Queen City Steel Treating Co.	Cincinnati, Ohio
Wesley Steel Treating Co.	Milwaukee, Wis.
Ontario Research Foundation	Toronto, Ontario, Canada

Manufacturers of Nitralloy Steel Castings

Lebanon Steel Foundry	Lebanon, Pa.
Empire Steel Castings Co.	Reading, Pa.
The Massillon Steel Castings Co.	Massillon, O.
Milwaukee Steel Foundry Co.	Milwaukee, Wis.
Warman Steel Castings Co.	Los Angeles, Cal.

NITRALLOY

THE HARDEST KNOWN STEEL SURFACE FOR WEAR RESISTANCE!

It holds tight because
THREAD PLAY IS ELIMINATED
with a resilient non-metallic locking collar

WHEN an Elastic Stop Nut is applied, thread play is automatically eliminated as soon as the end of the bolt presses against the locking collar which is built into the head of the nut. The load-carrying thread faces of nut and bolt are brought into contact under pressure.

As the bolt works its way through the collar, that pressure is increased. A positive grip is established which can not be loosened by vibration, shock or stress.

FOR a full explanation of the Elastic Stop principle, write for Catalog containing this and other data.

ELASTIC STOP NUT CORPORATION
2326 VAUXHALL ROAD • UNION, NEW JERSEY

Elastic Stop SELF-LOCKING NUTS

MAKE YOUR OWN *Blueprints*
FOR LESS THAN 1¢ PER SQUARE FOOT

REMARKABLE NEW *Simplex* BLUEPRINTER CUTS COST, SAVES TIME — NO EXPENSIVE EQUIPMENT. NO EXPERIENCE NECESSARY! • ACT NOW!

Don't give your money to outside firms for blueprints. With a Simplex Mercury Vapor-Tube Portable Blueprinter you can now make blueprints up to 42" wide (any length) in your own offices at a fraction of regular commercial prices. Makes 250 square feet per hour. Can be used for any of the Special Developing Processes. Requires no carbons or globes. Beautiful black crackle "Weaver" finish. Operates silently. Your office girl can easily operate a Simplex.

FREE TRIAL

FREE TRIAL! Don't take our word for the money-saving advantages of a Simplex! For a limited time only we will ship a regulation, complete Simplex Blueprinter on 30 days' free trial. Satisfaction guaranteed or money refunded. Write today for complete facts about this amazing, money-saving offer.

WICKES BROTHERS • SAGINAW, MICH.
511 NORTH WATER STREET

48 inches high. It operates with either cut sheets or roll stock, and prints ink tracings at from 12 to 15 feet per minute. A full-view speed indicator placed at the center of the front makes the speed readily visible at all times. An exclusive feature is the new print and tracing return. The entire top of the machine serves as a return tray and the return is so designed that the tracing enters the tray on top of the print, in exactly the same way it is inserted in the machine. A 55-watt mercury vapor quartz lamp is the light source, furnishing uniform exposure without flickering, and guaranteed for 1000 hours. A double centrifugal blower reduces operating noise and the transmission and motor are resiliently mounted to reduce vibration.

Socket Rotates in Complete Circle

ADJUSTABLE to a right angle, the Swivelier lamp socket is announced by Reliance Devices Co., 140 Liberty street, New York. It can be rotated to a complete circle, after adjustment at any angle. Its design compensates for wear caused by friction, so that the Swivelier will "stay put" in any position. Vibrations will not cause the swivel to work loose. There are no exposed wires. These sockets come in three standard finishes, dipped brass, brush brass, electronickel. Wires cannot twist, because of the special Swivelier stop. A strong spring guards against looseness.

Selecting Special Motors

(*Concluded from Page* 54)

The performance curves of an explosion-proof continuous-duty motor are shown in *Fig.* 6.

Applications of electric power in aircraft are ever increasing. Hydraulic power has several advantages and is widely used but the electrical system is often lighter and is considered less vulnerable to gun-fire on military airplanes. An example of the trend is a large flying boat now under construction which employs more than 20 electric motors ranging in size from 1/10 to 5 horsepower. As airplanes increase in size more and more functions will have to be operated by power drives. It seems likely that control surfaces, ailerons, rudders and elevators, will be power operated. Judging from the rapid advancement in automotive engineering after the last war, aeronautical progress should receive a tremendous impetus at the close of the present war. Commercial and private aviation will expand rapidly and the need for electrically driven accessories will increase in a corresponding manner. Continued progress in the reduction of weight and increase in dependability of electric motors may be expected.

In conclusion it may be said that high armature speeds, lightweight materials and high operating temperatures are the principal factors in reducing motor weight. In selecting a motor for a particular application the designer should allow for as high an armature speed as possible within the limits outlined. Consideration should also be given to special temperature conditions since they might alter the amount of power the motor can develop or affect its weight. Aluminum or magnesium castings may be utilized more widely.

OF FIRST IMPORTANCE—Design

THIRTY-SIX years of Roller Bearing manufacture have proved that design is the most important element in a bearing.

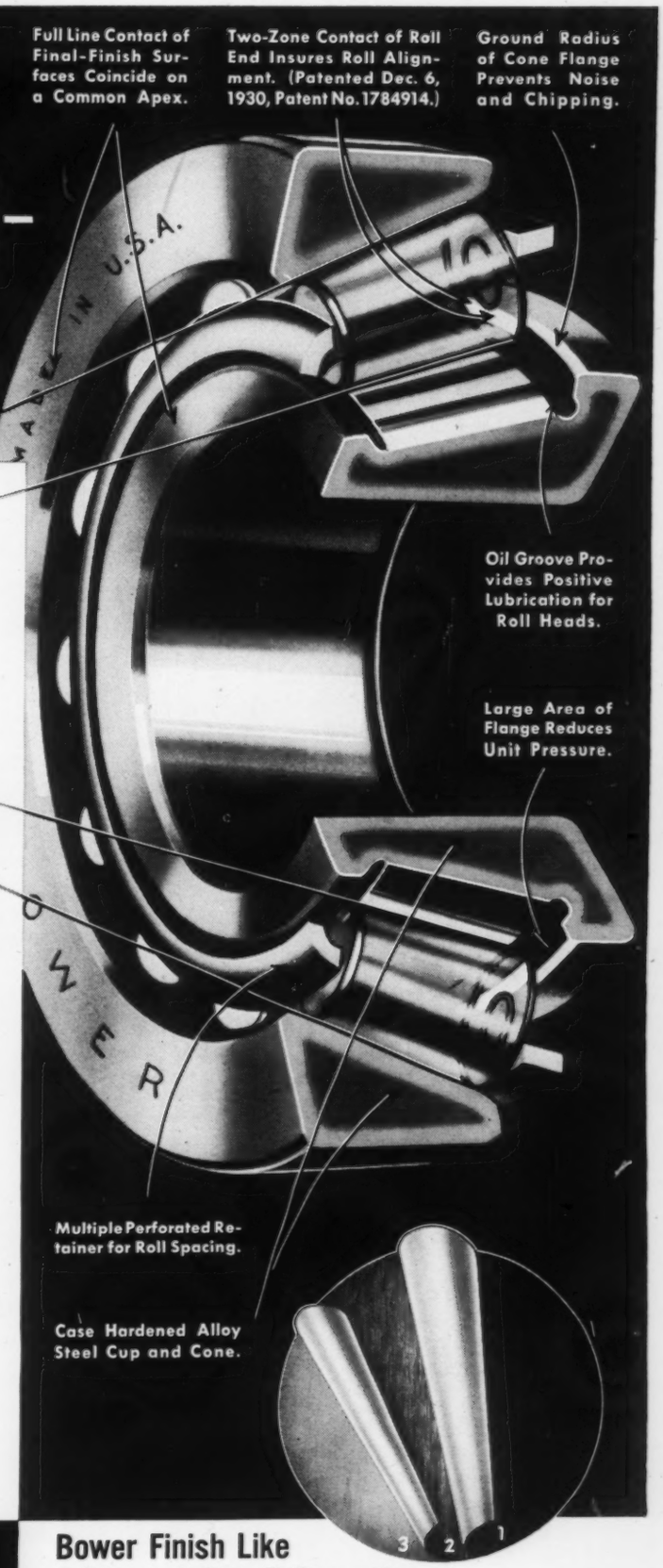
Likewise, the use of many millions of Bower Roller Bearings as original equipment over a period of many years in America's leading large-production automobiles has proved the correctness of BOWER DESIGN.

Bearing users will appreciate that the exacting standards of the automotive industry and the severe usage of bearings in automobiles offer a challenge that no roller bearing can meet unless it possesses the highest degree of quality known to the bearing industry.

One of the secrets of Bower's leadership is the fact that its technical men have never waited upon the ingenuity of other men. Bower engineers push relentlessly ahead—far beyond the needs of the moment—to make new technical discoveries and to apply them always in ADVANCE.

This Tapered Roller Bearing is a leading example of Bower design. It embodies important advantages that no other bearing possesses—advantages that Bower engineers discovered and incorporated ahead of all others.

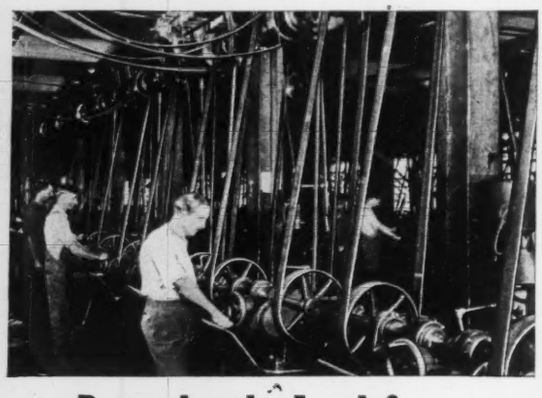
For more detailed information on Bower design, ask us for a copy of the folder, "Secrets of Bower Roller Bearing Design and Quality."


Full Line Contact of Final-Finish Surfaces Coincide on a Common Apex.
Two-Zone Contact of Roll End Insures Roll Alignment. (Patented Dec. 6, 1930, Patent No. 1784914.)
Ground Radius of Cone Flange Prevents Noise and Chipping.
Oil Groove Provides Positive Lubrication for Roll Heads.
Large Area of Flange Reduces Unit Pressure.
Multiple Perforated Retainer for Roll Spacing.
Case Hardened Alloy Steel Cup and Cone.
MADE IN U.S.A.
BOWER
3
2
1

Bower Finish Like A "Face-Lifting" Operation

1. ROUGH GROUND—Photomicrograph—25 diameters—showing amorphous film with roughness of approximately 15 micro-inches (millionths of an inch). **2.** FINISH GROUND—More but finer scratches—surface finish of approximately 10 micro-inches composed of amorphous metal left by finish grinding—Photomicrograph of 25 diameters. **3.** FINAL FINISH—25-diameter photomicrograph showing amorphous metal and grinding marks removed, baring hard surface and smoothness of approximately 3 micro-inches—scratches below surface.

BOWER
ROLLER BEARING CO.
Detroit, Michigan



Remember the Jungle? . . .

The jungle of belting which the most intrepid explorer would never have entered without a native guide? Bungling belting, like bustles, is gone. The Hilliard Clutch remains. Often hidden within the sleek exterior of today's machines, Modern Hilliard Clutches meet, with traditional Hilliard efficiency, the present demands of industry. That's why for 35 years design engineers have insisted—

"Specify Hilliard"

OVER-RUNNING SINGLE REVOLUTION SLIP CENTRIFUGAL

THE HILLIARD CORPORATION ELMIRA, N.Y.

WRITE TODAY
For the NEW
Friction Clutch Brochure
Address Dept. D-3

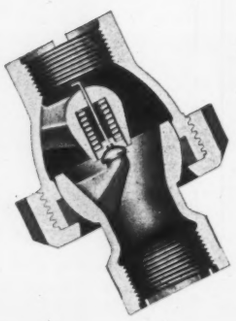
BARCO

STREAMLINED
FLEXIBLE BALL JOINTS

STEAM—AIR—GAS
OIL AND OTHER
FLUIDS

Stainless Steel Spring shrouded for protection against fluids, corrosion and erosion.

Spring pressure exactly centered against ball provides equal pressure of ball against gasket seat adjustment is automatic.



Spring Type Flexible
Ball Joint 7X-8X
Catalog 321

Barco Manufacturing Co.
Not Inc.
1806 Winnemac Avenue, CHICAGO, ILL.
In Canada: The Holden Co., Ltd.

Meetings and Expositions

March 4-5—

American Society for Testing Materials. Spring meeting to be held at The Mayflower, Washington. R. E. Hess, 260 South Broad street, Philadelphia, is assistant secretary.

March 10-13—

American Society of Bakery Engineers. Annual meeting to be held at Edgewater Beach hotel, Chicago. Victor E. Marx, 1541 Birchwood avenue, Chicago, is secretary.

March 11-13—

American Railway Engineering association. Annual meeting to be held at Palmer House, Chicago. W. S. Lacher, 59 East Van Buren street, Chicago, is secretary.

March 12-13—

American Society of Mechanical Engineers. Special national meeting on defense to be held at Statler hotel, Cleveland. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

March 13-14—

Society of Automotive Engineers Inc. National Aeronautic meeting to be held at Washington hotel, Washington. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

March 17-22—

Oil Burner institute. Annual meeting to be held at Benjamin Franklin hotel, Philadelphia. C. F. Curtis, 30 Rockefeller Plaza, New York, is secretary.

March 25-29—

American Society of Tool Engineers. Machine and Tool Progress exhibition to be held at the Convention Hall, Detroit. Additional information may be obtained from Ford R. Lamb, 2567 West Grand boulevard, Detroit, executive secretary.

March 28-30—

Laundry and Cleaners Allied Trades association. Exhibition and clinic to be held at the Municipal Auditorium, Memphis, Tenn. Roger R. Jackson, 95 Liberty street, New York, is manager.

March 31-April 3—

American Society of Mechanical Engineers. Spring meeting to be held at Atlanta, Ga. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

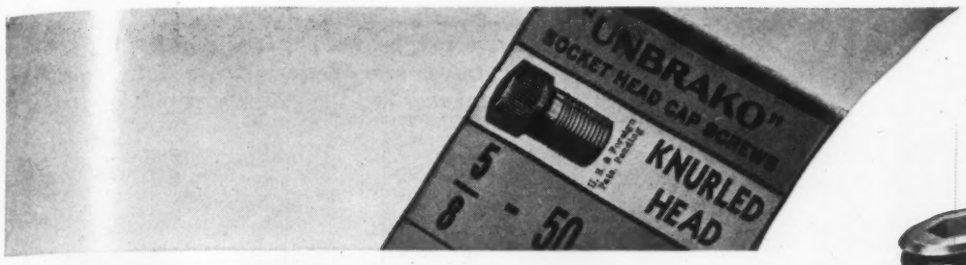
April 1—

Packaging Machinery Manufacturers Institute. Semiannual meeting to be held at Stevens Hotel, Chicago. H. L. Stratton, 342 Madison avenue, New York, is secretary.

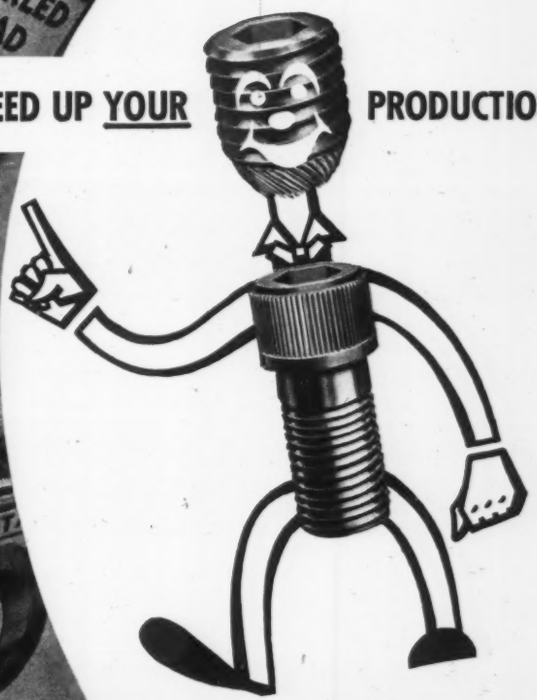
April 9-10—

Midwest Power conference, sponsored by Illinois Institute of Technology, Chicago, to be held in the Palmer House, Chicago. Additional information may be obtained from the institute.

CORRECTION: In ". . . . designing minimum bends" by Louis G. Blumenbaum, beginning on Page 73, M. D., February 1941, the two final equations should read $R = 50T^2 - T$ and $R = 64T^2 - T$ instead of as shown. The curves in the blueprint are based on the correct equations.



HOW "UNBRAKO" KNURLED HEADS CAN SPEED UP YOUR PRODUCTION



UNBRAKO

SOCKET HEAD
CAP SCREWS
"They're Knurled"

Suppose the winding stem of your watch, instead of being knurled, is smooth and oily . . . suppose your fingers are greasy when you try to wind. Slippage, annoyance and time-wasting inefficiency are the result.

Now think of your production line. Multiply these conditions and results by the number of socket head cap screws your mechanics have to handle in a day . . . and you'll see why so many plants are now using the Knurled "Unbrako" exclusively because of the time and money they save.

The knurled heads gear right to the fingers, prevent lost motions, turn faster and farther before applying wrench or pliers.

In addition, the knurling also permits quick and easy locking of the screw after countersinking—a distinct advantage.

There are other advantages, too—all at *no extra cost!* Write, or ask your distributor.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 102

— BRANCHES —

BOSTON · DETROIT · INDIANAPOLIS · CHICAGO · ST. LOUIS · SAN FRANCISCO

Stephen Decatur Was Right!

he said:

"Our country! In her intercourse with foreign nations may she always be in the right; but our country, RIGHT OR WRONG!"

In line with this theme, we have greatly increased our capacity to take care of defense orders and are doing everything within our power to shoulder the responsibilities placed upon us.

At the same time, we are earnestly endeavoring to fulfil our obligations to our customers and users of Kropp Hammer, Drop and Upset Forgings not engaged in defense work.

Ours is a will to serve!

KROPP

KROPP FORGE COMPANY

World's Largest Job Forging Shop

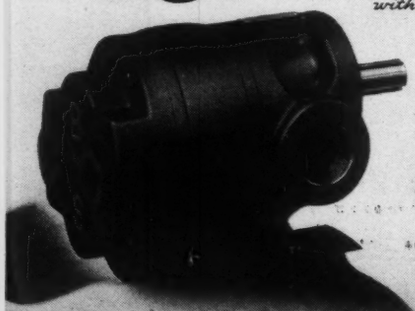
5307 W. Roosevelt Road, Chicago, Ill.

Representatives in Principal Cities

For Hydraulic Installations —

the 500 Series ROTARY GEARED PUMPS

with HERRINGBONE GEARS



—Quiet in operation ... for pressures up to 500 lbs.

Ask for circular

Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

BROWN & SHARPE B·S PUMPS

(Concluded from Page 62)

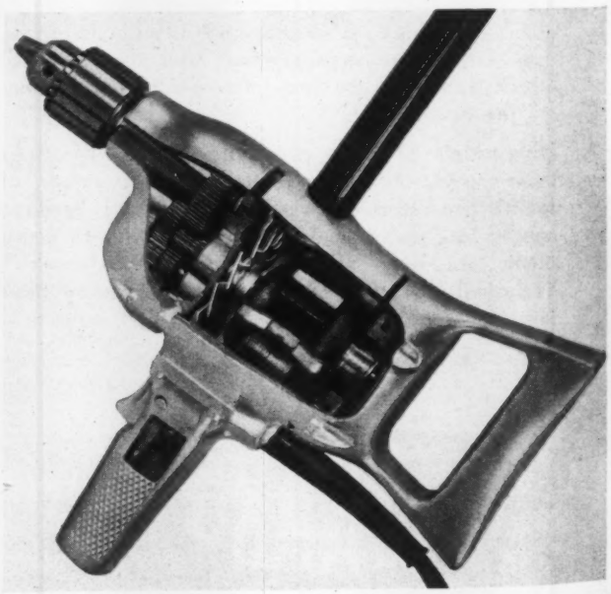
shielded arc type welding rod for S.A.E. 4130 and X-4130, these welds respond to heat treatment in a similar manner as the parent metal. Suitable for welding in all positions, the rods produce good crater conditions with a minimum of weld spatter.

Landing gear assembly of molybdenum steel tubing is welded by new rod

Brazing for Weight Reduction

KEEN interest is being displayed by engineers in the new aluminum brazing process. This technique has been instrumental in contributing to the success of Black and Decker's redesign of their portable electric drill. The new drill, illustrated, gives evidence of close attention to detail in the development of the new method and the utilization of aluminum for minimum weight and maximum ease of manipulation.

Not only is the housing made entirely of aluminum but even the motor cooling fan. Formerly made of steel, in the redesigned fan the hub and blades are formed in two separate units and assembled by aluminum brazing. The clean fillet weld produced by this operation can be seen in the illustration.



Aluminum brazing of motor cooling fan results in reduced weight, increased economy in electric drill

MORSE ROLLER CHAIN

CARRIES ITS OWN

LIFE INSURANCE

In Every Link

THE HEART of a roller chain—the pin and bushing surfaces—is the part that requires the protection of dependable, adequate lubrication. And Morse channel lubricated roller chain's design assures that lubrication. Oil gets in, wear stays out.

The channels on the outside of the bushings lead oil from the rollers through the sideplates to the pins. The life-saving lubrication spreads over the entire surface of the pin and bushing contact areas, and the chain turns easily, smoothly, and efficiently on a film of oil.

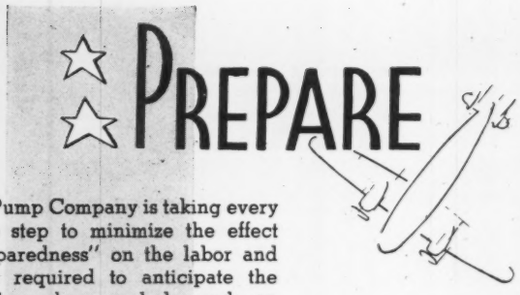
With Morse roller chain, you get long life, high efficiency, freedom from repair and maintenance expense, and low first cost.

Next time you buy roller chain, specify MORSE!

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

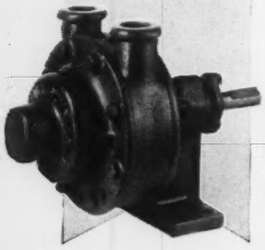


Tuthill Pump Company is taking every possible step to minimize the effect of "preparedness" on the labor and material required to anticipate the inevitable and unusual demands on suppliers for 1941.

You can rest assured that Tuthill will be in better position than ever before to supply requirements for industrial pumps—for coolant and lubrication service as well as for the operation of hydraulic mechanisms.

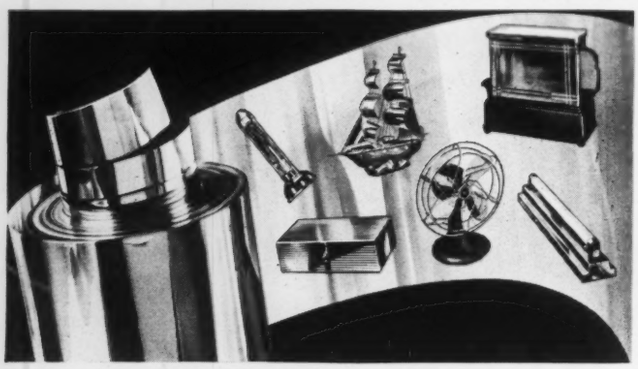
Write for catalog.

As Usual, It's TUTHILL for DEPENDABLE PUMPS



TUTHILL
PUMP COMPANY
941 EAST 95TH STREET
CHICAGO • ILLINOIS

THE ANSWER TO MANY METAL FABRICATING PROBLEMS...



American Bonded Metals

We offer you more than America's finest pre-finished metals . . . we offer you sound, basic, common-sense production economies. These economies are possible through the simplification of your entire production routine . . . with metals that require no plating, polishing or refinishing before or after fabrication. Forty-three years' *specialized* experience enables us to discuss your problems intelligently. Let us explain how Pre-Finished Metals can help you reduce costs and speed up production.

NICKEL, CHROMIUM, BRASS OR COPPER
Electro-Bonded SHEETS • COILS TO ZINC, STEEL, BRASS, COPPER, ALUMINUM OR TIN PLATE

AMERICAN NICKELOID COMPANY
1322 NORTH SECOND ST. — PERU, ILLINOIS

Theory of Elasticity in Practical Design

(*Continued from Page* 39)

constants in the function by the extension of the stress system of Equations 33 to the boundary.

Stress functions in the form of polynomials in x and y will give solutions particularly applicable to narrow rectangular plates. As an example assuming

$$\phi_2 = A_2 y^3$$

Substitution in Equation 34 shows it satisfied and therefore the distribution determined from ϕ_2 will be compatible with the concept of a "continuous distribution of the strain."

Substitution in Equation 33 gives for the stresses

$$S_x = 6A_2 y;\ S_y = 0;\ v_{xy} = 0$$

Substitution of these results directly in Equations 1, 2 and 28 will show them satisfied, checking this as a permissible distribution.

Condition Is Uniform Bending

Extending this system to the boundaries of a rectangular plate, since the shear at all points is equal to zero, there will be no friction loads at any point on any boundary. Since S_y is equal to zero there will be no normal loads on the horizontal boundaries. The value of q on the ends is given by S_x. If the coordinate axes are located as shown in *Fig.* 11, the resultant of the forces on each end will be equal to zero. Therefore the condition is that of a beam under uniform bending.

The moment applied to each end is given by

$$M = -4A_2 c^3 b$$

the negative sign appearing following the convention usual for the positive direction of moment, as shown in the figure. Expressing $c^3 b$ in terms of the inertia I of the section area

$$c^3 b = \frac{3I}{2}$$

Substituting in the expression for M and solving for A_2

$$A_2 = -\frac{M}{6I}$$

Substituting this value of A_2 in the original stress values

$$S_x = -\frac{My}{I};\ S_y = 0;\ v_{xy} = 0 \qquad (35)$$

a solution which is in exact agreement with the conventional theory of Strength of Materials.

To further illustrate this method another solution

WORM GEARING

10 to 64 D.P.

High Precision
—or
Mass production

A few pieces
or a million

As you want them—
When you need them

For fractional H.P. applications of all kinds. Speed reducing gears in the smaller range . . . *Special* facilities for GRINDING and POLISHING worm and screw threads before or after hardening.

ALSO SPURS—SPIRALS—BEVELS

Made to order only—No stock—No catalog

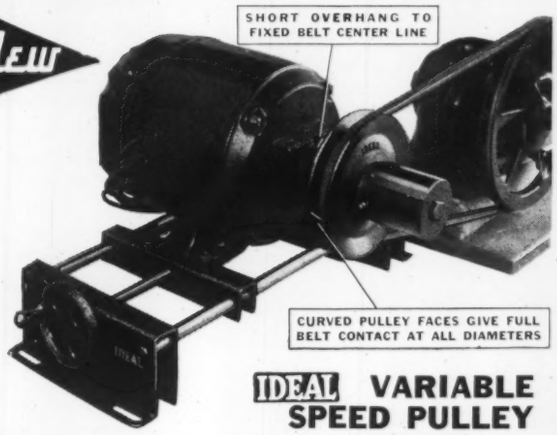
Gear Specialties

2670 W. MEDILL AVE. Phone Humboldt 3482

CHICAGO

VARIABLE SPEED

New



IDEAL VARIABLE SPEED PULLEY
(V-BELT SERIES)

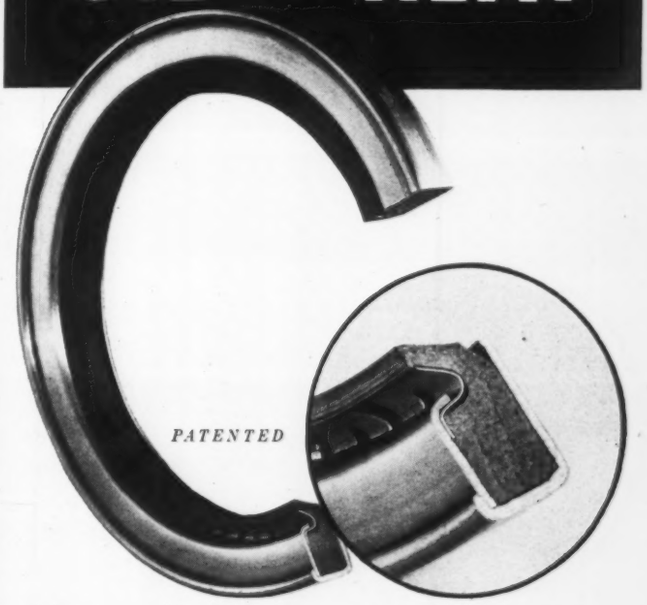
OUTSTANDING FEATURES—

- Inexpensive—Dependable.
- Gives infinitely variable speed over wide ratio.
- Uses standard V-belts.
- Curved sheave faces assure full belt contact at all pitch diameters.
- Belt is always in alignment.
- Compact — minimum overhang to belt centerline.
- Easy to install—mounts direct to motor shaft.
- Speed changed while running.
- Balanced Sheaves.
- Sizes up to ¾ H. P.

Write for information on the complete line of IDEAL Transmission Equipment. Experienced Transmission Engineers are at YOUR service.
ASK FOR FREE TRIAL DEMONSTRATION

Transmission Division
IDEAL COMMUTATOR DRESSER COMPANY
1059 PARK AVENUE SYCAMORE, ILLINOIS
"Sales Offices in All Principal Cities"
In Canada: Irving Smith, Ltd., Montreal, Que.

THE OIL SEAL THAT RESISTS OIL *and* HEAT



THE exclusive compound used in the sealing ring of a Garlock KLOZURE has those characteristics which are vital to a material whose function is to keep oil in and dirt out of a bearing; it is non-porous, non-abrasive, resilient, tough and durable—and it has unusual resistance to oil and heat. The KLOZURE Oil Seal is manufactured in a complete range of shaft and bore sizes, including Metric O. D.'s to fit bearing manufacturers' standard bores. Write for catalog.

THE GARLOCK PACKING CO.
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Garlock KLOZURE

will be derived. Assuming as the stress function

$$\phi_3 = A_3 xy^3$$

Substitution in Equation 34 shows it satisfied. Substitution in 33 gives for the stresses

$$S_x = 6A_3xy;\ S_y = 0;\ v_{xy} = -3A_3y^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (36)$$

and extending this system to the boundaries of a rectangular plate gives the loading shown in *Fig.* 12.

Adjusting the constant in the "pure shear" solution of *Fig.* 7 so that the shear loads on the upper and lower boundaries will balance those in *Fig.* 12. This gives for the constant A_1

$$A_1 = 3A_3c^2$$

giving for the "pure shear" stress of *Fig.* 7, $v_{xy} = 3A_3c^2$, $S_x = S_y = 0$. Adding this system to that of Equation 36 gives

$$S_x = 6A_3xy;\ S_y = 0;\ v_{xy} = 3A_3(c^2 - y^2) \quad \ldots\ldots\ldots\ldots\ldots (37)$$

These equations could also have been obtained directly by taking the stress function in the form, $\phi = -A_1xy + A_3xy^3$ and determining A_1 by the condition that $v_{xy} = 0$ when $y = \pm c$. Extending this system to the boundaries gives the loadings shown in *Fig.* 13. This is a cantilever beam with a distributed vertical load applied at the end $x = 0$ and fixed at the end $x = l$.

Summation of the forces on the left end, P, is given by

$$P = \int_{-c}^{+c} v_{xy} b\,dy = 3A_3b \int_{-c}^{+c} (c^2 - y^2)\,dy = 4A_3bc^3$$

Now substituting for bc^3 in terms of I and solving for A_3

$$A_3 = \frac{P}{6I}$$

Substituting this in S_x of Equation 37 and noting that $M = -Px$ . . . . . .

$$S_x = -\frac{My}{I};\ S_y = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (38)$$

which is the same as Equation 35 for uniform bending.

Substituting for A_3 in v_{xy} of Equation 37

$$v_{xy} = \frac{P}{2I}(c^2 - y^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (39)$$

This may be reduced to Equation 3 by substituting for M_s as given there, and noting that $V = -P$. This solution is also in full accord with elementary theory. The shear stress has a parabolic distribution, being zero at the horizontal boundaries and a maximum at the center. This maximum is 50 per cent more than the average as given by P/bd.

This discussion will be continued in the next issue and will cover variations in stresses adjacent to a load as well as elemental analysis of straight members.

MOTORS
Tailored to fit your Needs
MANY times a motor with standard windings is not the best motor for the job. Or a change in frame design or size means a better application to your product.
Peerless is equipped to handle large or small orders of any special design that will give you maximum motor efficiency, trouble-free operation and minimum upkeep. Send us your motor problems. 47 years of building motors have given Peerless engineers experience in meeting any motor problem.
THE Peerless ELECTRIC CO.
WARREN, OHIO

"LOGAN"
FOR 25 YEARS
"LOGAN" Air & Hydraulic
Equipment Has Saved
TIME - EFFORT - MOTION
This year marks "LOGAN'S" twenty-fifth anniversary. During those years "LOGAN" has solved production problems and speeded up manufacturing in most of the largest industrial plants in the world. And now in these days of great stress "LOGAN'S" entire resources and manpower are being devoted to the defense of America in her Armament Program. Let "LOGAN" Representatives and "LOGAN" Engineers make recommendations on your production problems.
Logansport Machine, Incorporated
911 Payson Road Logansport, Indiana
Manufacturers of Air and Hydraulic Devices,
Chucks, Cylinders, Valves, Presses and Accessories.
"LOGAN"
HYDRAULIC
LOGAN
HYDRAULIC

Business and Sales Briefs

WITH movement of personnel and equipment completed, Chicago district activities of the General Electric Co. and its affiliates are housed in GE's new $1,500,000 building in Chicago. Formerly they were scattered in nine separate locations. Occupying an entire city block the building is seven stories high, one-third of its space being allocated to offices and the remainder for warehouse, display and servicing facilities. Sales, engineering and servicing operations in 11 midwestern states and parts of three others will be directed from this center.

♦

A program of market research and related activities has been put into effect by the Seamless Steel Tube institute, 3510 Gulf building, Pittsburgh. Director will be W. A. Cather, now advertising manager of the Babcock & Wilcox Co., New York. Mr. Cather will operate out of the institute's Pittsburgh offices and also the offices of the Michel-Cather organization at 2 Park avenue, New York.

♦

Appointment of the John W. Clarke Co. as representative in the Chicago territory is announced by the Roller-Smith Co., Bethlehem, Pa. This territory comprises the northern half of Illinois, northern Indiana, Wisconsin and eastern Iowa. The Clark company offices are at 327 South La Salle street, Chicago. This appointment was necessitated by the recent death of E. E. Van Cleef, who represented Roller-Smith for a number of years in this area. M. B. Mathley, formerly with Mr. Van Cleef, will be associated with the Clarke company, as will C. Swain Lumley, Roller-Smith district engineer who formerly was located at 53 West Jackson boulevard.

♦

Jones & Laughlin Steel Corp., Pittsburgh, has licensed three large steel companies to use its bessemer flame control method for making bessemer steel. License agreements have been made with Republic Steel Corp., Cleveland; Youngstown Sheet & Tube Co., Youngstown, O.; and Wheeling Steel Corp., Wheeling, W. Va. In addition, the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., has been licensed.

♦

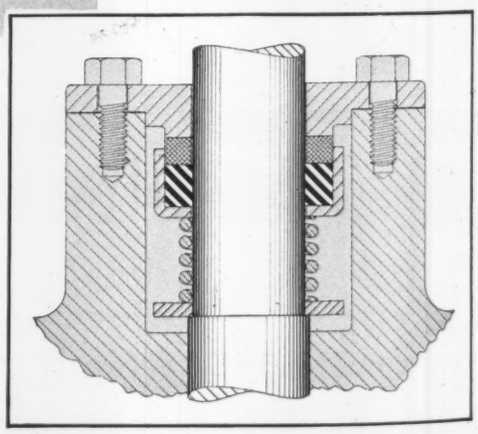
With opening of a new plant in Cleveland at 5105 Cowan avenue, Harris Products Co., Detroit, has moved the major portion of its production of Torflex rubber and neoprene-backed bushings to Ohio. A branch sales office has also been established. Some manufacturing facilities will be maintained at Detroit, and design, development and testing capacities there are being enlarged.

♦

Several changes and additions have been made in the sales organization of Manning, Maxwell & Moore Inc., Bridgeport, Conn. T. J. Naughton, formerly of the Chicago office, has been transferred to Minneapolis and will cover Minnesota and North Dakota, with portions of South Dakota, Iowa and Wisconsin. E. C. Robinet, formerly in Los Angeles, has been transferred to Seattle, where he will cover the Pacific northwest territory. Representative in the Charlotte, N. C., district will be J. E. Day. W. F. Williams, an experienced oil industry man, will work with accounts in the oil industry, out of Chicago. Charles Stepan, Chicago, has been promoted to the newly-created position of manager of sales of Consolidated House Heater boiler safety valves, House Heater boiler gages, Ashcroft

CASE HISTORY No. 87
FROM OUR CORPRENE FILES

This Armstrong's DC-100 Corprene packing ring, which is compressed between cup and shaft, seals on the shaft surface and resiliently supports the carbon ring. Low radial pressure allows axial movement to compensate for carbon ring wear.



PROBLEM: To find an efficient resilient packing ring for a seal assembly

A MANUFACTURER of gear pumps had difficulty with the resilient packing rings used in his shaft seals. Rubber-like rings often failed due to their tendency to creep or flow. Harder rings were tried, but they too were unsatisfactory. When made tight enough to prevent leakage, they would often bind on the shaft, and not permit adjustments to correct for wearing losses in the carbon seal rings.

Then Corprene DC-100 rings were tried. These rings, differing from the rubber-like materials, were compressible. They were made slightly small on the inside diameter and slightly large on the outside diameter. This resulted in radial compression *without* axial flow when they were assembled in the packing cups and placed on the shafts. Due to the compression characteristics of Corprene, a tight seal was maintained with a low radial pressure. This low pressure allowed axial movement to compensate for carbon ring wear. The cork content of the Corprene rings prevented cold flow or creeping. Corprene's resilience permitted enough flexibility in the assembly to maintain a tight seal between the carbon rings and the glands. No seal failures have been reported since Corprene was adopted.

Perhaps Corprene is just what *you* are looking for. There are more than two dozen standard Corprene compositions available—made in sheets and molded and cut pieces. The physical properties of these versatile materials can be "tailor-made" to fit your specifications. That is, Corprene's compressibility, lateral flow, chemical and solvent resistance, coefficient of friction, hardness, tensile strength, and other characteristics can be *controlled according to your requirements.*

If you have sealing trouble, or any other engineering problem that a cork-and-synthetic-rubber material might solve, write us today. Armstrong Cork Company, Industrial Division, 942 Arch Street, Lancaster, Pa.

Armstrong's CORPRENE
COMPOSITIONS OF CORK AND SYNTHETIC RUBBER

Simple, Sturdy

CJB **AHLBERG**

Ball Bearing

PILLOW BLOCKS

1. Precision self-aligning ball bearing.
2. One-piece sturdy housing.
3. Removable end cap.
4. No drag labyrinth seals.
5. Simple mounting wrench.

THESE CJB pillow blocks are not a new development, but a proven design, with a ten year service background.

Their compactness and simplicity of design make them ideal for light and normal service, where a reliable yet inexpensive bearing is required.

The full self-aligning, precision type ball bearing, is mounted in a one piece, Parkerized, and accurately machined housing. Seals, to protect the bearing and retain lubricant, are non-wearing Neoprene rings, which turn with the shaft and float in the housing.

This labyrinth type of seal is frictionless, long wearing, and exceptionally effective.

This series is available in shaft sizes from $\frac{9}{16}$" to $2\frac{3}{16}$", in either fixed or expansion types. Closed end type is optional.

Send for new 96-page Catalog No. 440 which gives detailed information on the complete Ahlberg line of Ball Bearings, Roller Bearings and Ball Bearing Pillow Blocks.

AHLBERG BEARING COMPANY

Manufacturers of CJB Master Ball Bearings

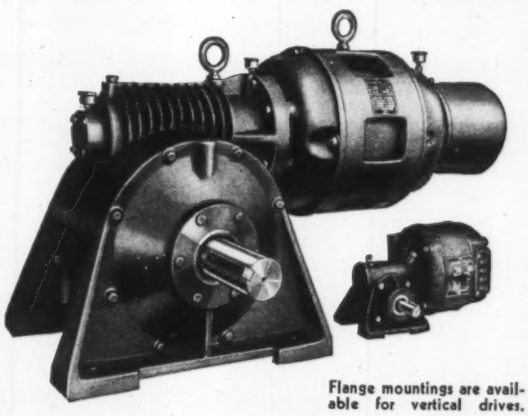
3017 West 47th Street - - - Chicago, Ill.

Janette

MOTORIZED SPEED REDUCERS

FOR YOUR SLOW SPEED DRIVES

1/50 TO 10 H.P. . . . . .08 TO 1140 R.P.M.



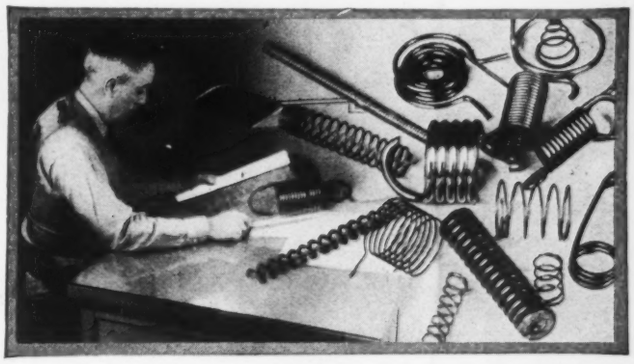
Flange mountings are available for vertical drives.

Janette is one of the very few companies who build BOTH motors and gear boxes. Janette motors are designed ESPECIALLY for use with speed reducers. All machines are built COMPLETE in our own factory by our own organization. There is no DIVIDED responsibility for the performance of either the gear box or motor.

SEE OUR SPEED REDUCERS AT THE A.S.T.E., BOOTH 378, MACHINE & TOOL PROGRESS EXHIBITION AT DETROIT, MARCH 24-29

Janette Manufacturing Company

556-558 West Monroe Street Chicago, Ill. U.S.A.



Do Springs Get in Your Hair?

MAYBE that's because figuring out spring sizes, stresses, materials, etc., is not so simple as it seems. Besides making springs well and delivering them promptly, Peck Service offers you engineering help if you need it. So, if you have a "touchy" spring problem, send us a description of it. We help others; we should be able to help you. Also,

SEND FOR SPRING ENGINEERING DATA

—a useful treatise for any one charged with the ordering of helical springs. No charge, but please request it on your letter head.

PECK SPRINGS

AND SCREW MACHINE PARTS

The Peck Spring Co. **10 Wells St., Plainville, Conn.**